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Grand River Crossing—Spavinaw Water-Supply Conduit

Earthquake-Resistant Construction Suggestions from Tokyo

Driving a 6-Mile Railway Tunnel

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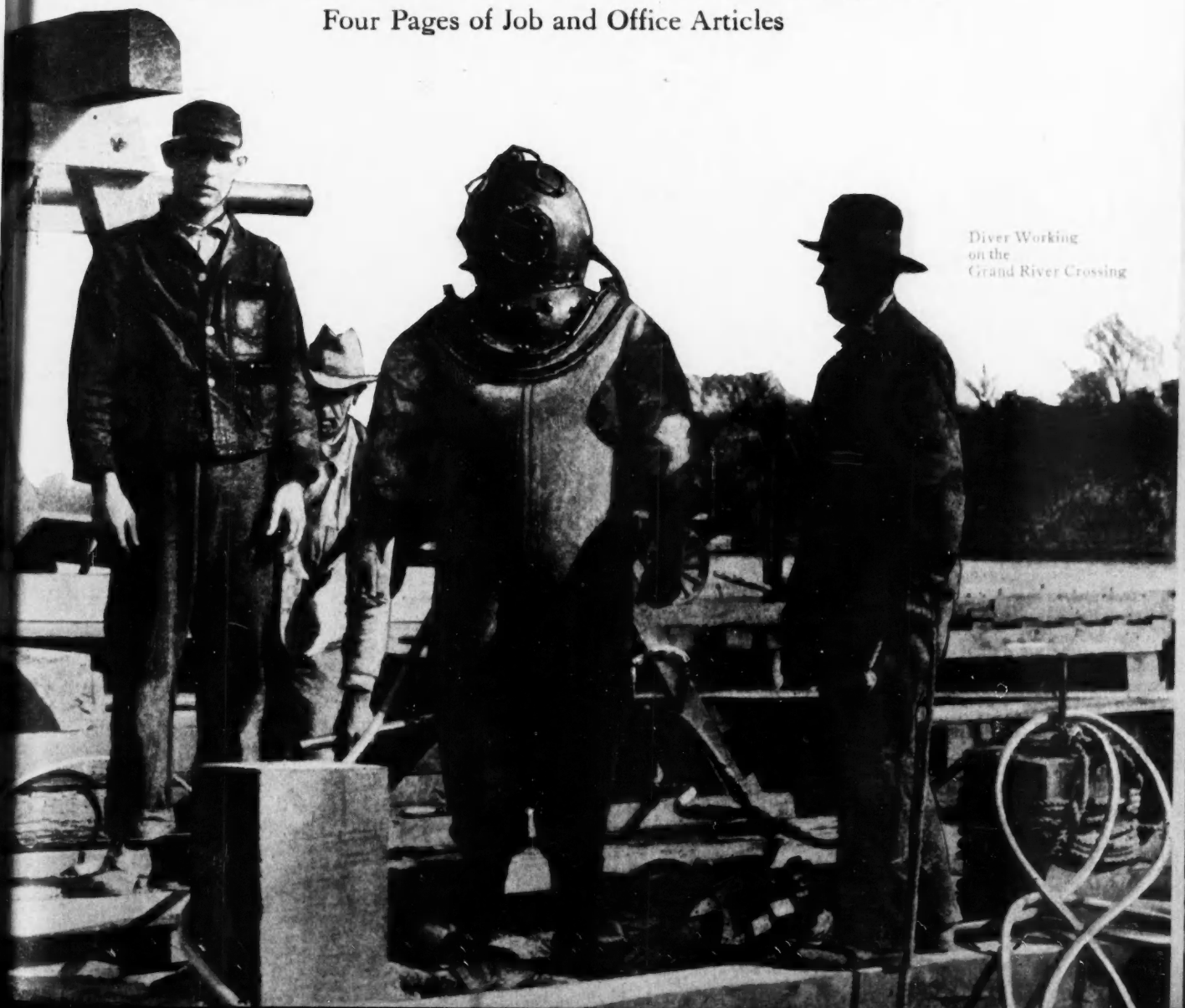
Four Pages of Job and Office Articles



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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

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Highway Cutoff Costs

FIVE years ago the highway commissioner of Connecticut addressing a convention of road builders asserted that the elimination of "bottle-necks" in main roads was an imminent problem whose solution would soon call for large expenditures. The statement failed to register strongly for then, as is the case yet in many states, official concern was directed chiefly to the problem of obtaining mileage of improved road rather than to problems of speeding traffic on main routes of travel. Conditions have altered greatly in half a decade. Today highway engineers in all sections where traffic is accumulating are making and planning large expenditures to do away with constrictions in highways. A typical example is furnished by the building in New Jersey of the cutoff, in the seashore road, at Morgan. Here a "bottle-neck" formed by sharp curves, a steep hill and a railway crossing at grade has been eliminated by a new cutoff just over a half mile long. Traffic capacity has been increased 25 per cent. Few who know the congestion and the hazard under the old conditions and have experienced the relief afforded by the new route will question its justification or the wisdom of any reasonable expenditure to provide it. The point to be noted is that this expenditure must invariably be large. Including the railway's share for an overhead bridge the Morgan cutoff has cost perhaps $150,000. It is an expensive half-mile of road building and so must be all of scores of similar improvements required in every state where highway development is great. This is a lesson which road officials must find means to teach the public.

Special Legislation

THE ingenuity spent in circumventing state constitutional prohibitions against special legislation affecting minor civil divisions is sometimes amusing. A case in mind is Chapter 476, Laws of New York, 1925, entitled "An act to amend the town law, in relation to the establishment of districts for the collection and disposition of garbage or ashes or both in certain towns." In its application this act is limited in this fashion: "In a town within a county having less than 300,000 inhabitants and adjoining a city having over 1,000,000 inhabitants, a district for the collection and disposition of garbage or ashes or both may be established . . ."; which being interpreted means towns in Nassau County only. The amendment fills five pages. Its sole effect is to authorize a portion of any town in Nassau County to form itself into a district for the collection and disposal of garbage and ashes under the general supervision of the town boards of supervisors in which the area to be served is located The initiative is by a petition signed by 10 per cent of the owners of taxable real estate in the proposed district, as is also the choice of district commissioners and the voting of bonds for district purposes. The amendment takes great care to see that property owners outside of any village shall not be subject to possible domination by a village in the district in case one is included. The entire amendment is so comprehensive and governmentally sound as to make it all the more regrettable that the act is not statewide in its possible application. The statute books of New York and some other states are burdened with this sort of narrow legislation, which accounts in large part for the flood of local bills that swamps many of our legislatures, constitutional prohibitions to the contrary notwithstanding.

Corrosion Testing

ABLE statistical minds compute every now and then just how many millions of dollars go to waste each year through rust. The same waste will continue for many generations, as progress toward corrosion-resistant metals is imperceptibly slow. It is true that slow-rusting steels have been developed during recent years for special uses where cost is not a primary requirement, that means have been found to improve slightly the resistance of ordinary steel to atmospheric corrosion, and that aluminum and various alloys have been applied to many uses for which ferrous metals were objectionable because of corrosion But these items of progress are relatively insignificant, and we still look forward to the time when we shall know more about corrosion and its inhibition. Methods of studying and measuring corrosion engage much attention in the meantime; the two papers abstracted on pages 185 to 187 are good illustrations. But even here we are in rather backward condition, for there is no agreement on how corrodibility should be tested and measured. So-called accelerated tests do not match actual exposure conditions, and on the other hand actual exposures—to the atmosphere, to mine water, to sea air, to smoke—are not reproducible or constant and therefore can have hardly more than approximate qualitative meaning. Since precise comparisons are necessary, the prospects are that main dependence must be placed in accelerated tests (such as that used by Mr. Fowle for comparing conductor strand), with frequent check-up by parallel exposure tests. The hope of finding a single accelerated test of universal application, however, is not very promising, as there is too much variability in the nature and intensity of the exposure, whether atmospheric, liquid, or spray. More than likely we will in time have a number of artificial corrosion tests, each fairly well standardized to suit a particular type of corrosive exposure. They should contribute materially to progress in the fight against corrosion.

Superior Rights

THE war between water and land as a transportation medium is always with us. Because centuries ago in Merrie England the roads were poor and the rivers carried the freight, and because, too, the rivers were

there before the roads, river navigation had always the right of way. The English common law persists in our land and time. A drawbridge can be required on almost any crossing providing the War Department can be persuaded that possibly some time there may be navigation. Moreover the water still commands the right of way and thousands of land passengers are being daily delayed so that a garbage scow or a sand barge may make its leisurely passage to its destination. The barge never accommodates itself to the train; the train must always give way. But the shipping interests are not satisfied now with drawbridges. They want high and wide fixed bridges and they flock to Washington in defense of their ancient right every time a draw is proposed. And generally their plea is answered. Law is law, we suppose, and common law doubly so. Ancient rights are the basis of our polity. But it does seem that there should be some better way of adjudicating the relative value to the community of two conflicting modes of transportation than one based on the mere possibility of future use, which is so often governing in these conflicts. It is even conceivable that the abolition of some waterway routes would not bring about complete decay of national commerce.

Typical Confusion

ELEVEN men, more or less, are on trial in Boston to determine whether they are responsible for the collapse of an old building on the morning of the 4th of July. There appears to be complete confusion as to who, if anybody, was charged with the duty of seeing that the building was safe. This situation is typical; every building failure repeats it, and criminal prosecutions have been uniformly unsuccessful in allocating responsibility. In the present case a various group of men is on trial, including architects, repair contractors, contractors and superintendents of a new building, and municipal building officials, one or more of whom appears to be suspected of having done something to bring down the old building. At first glance the circumstances of the case are complicated. A dance was in progress on the second floor of the old building, and there had been a fire in the building not long before the accident, which required various repairs to be made. The side wall had been underpinned to prepare for the erection of a garage alongside. Excavation was in progress on the garage site, and had gone down to a depth of 12 or 14 ft. However, from the nature of the collapse and the fact that half a dozen of those indicted were connected with the construction of the garage, it may be surmised that principal suspicion is directed to the excavation work and associated operations. It is here that we find the confusion of responsibility. A piece of work involving many risks—building operations always contain risks—and possible danger to neighboring structures, was being carried on. With direction of this work centered in one person, fitted by knowledge and ability to deal with the foundation and building problems arising, there could be little doubt as to where to place the blame for accident and it would not be necessary to indict and try a dozen people; but it is altogether likely there would be no accident, and therefore no blame. Divided authority and divided responsibility, the most common evils of building work, very often mean no direction and no responsibility.

Cross-Connections and Typhoid

THE searching investigation made by the Public Health Service to determine the causes of the excessive typhoid fever in several American cities last winter left public water supplies free of suspicion in all but two of the cities while in one of those a large majority of the typhoid cases were attributed almost wholly to oysters. The exceptions are Washington, D. C., where only 9 of 63 cases are charged to water and Pittsfield, Mass., where water is held to have been the "main factor" in the 28 cases of typhoid investigated. At Washington 9 cases of typhoid and many cases of diarrhea are charged against the "inadvertent pumping of raw water from Anacostia River into one of the city water mains" through a cross-connection with an industrial plant which had drawn on the city mains through the day while one man was on duty, and then, under a night man, resumed pumping raw river water without the closing of the cross-connection valve, with the result that the apparent high pressure of the raw water forced it into the city mains. This "inadvertent" act is held responsible for one-fourth (9 of 36) of the primary cases of typhoid believed to have been contracted *within* Washington—another indictment of the "deadly cross-connection."

Without questioning at all the conclusion that the Pittsfield outbreak of 28 typhoid fever cases and several hundred cases of diarrhea last November and December was probably due in the main to the public water supply, as stated in the preceding note, the evidence does not seem to be so thoroughly presented for Pittsfield as for Washington. The possibility of infection through a cross-connection at Pittsfield is not mentioned. Perhaps it does not exist. At least a sentence on that subject might well have been given. As it is, the Pittsfield outbreak, by far the worst on the "excess case rate" basis (cases in excess of "expectancy" were 390 per 100,000) of all the 13 outbreaks chosen for study, is given less than a page in the Public Health Service bulletin. The water-supply conditions at Pittsfield are complex in that the city takes water by gravity from four gathering grounds; but simple, the report holds, in that because of Y-connections and variable pressures, all parts of the city have a mixed supply. The cases were fairly well distributed geographically but there were none "among the wealthy or those associated with wealth"—which strange conclusion for a water-borne outbreak the report does not attempt to explain. The only evidence of water pollution offered in the report is (1) that there was "a very heavy and prolonged downpour of rain on Nov. 22" and (2) "that two of the watersheds had not been depopulated as supposed, and the water from these sources gave a rather high B. coli count, while that from the other two showed no colon bacilli." This is presumptive evidence of pollution from two of the four watersheds, but before accepting it as final one would like to know the relative areas and amount of storage on the two pairs of gathering grounds and also, as has been intimated, whether there were any cross-sections at Pittsfield and if so their number and condition. If none of these things were factors, then the Pittsfield typhoid of last winter is all the more notable as a water-borne outbreak, and becomes doubly or trebly notable—unless some other explanation than that given by the Public Health Service, can be made and accepted—because it

occurred in Massachusetts, where such happenings are rare. Finally, one would like to know whether the Pittsfield water supply was being chlorinated last winter, and if not then, whether it is now, and if not even now then what is being done for its protection today.

Tolls or Taxes

A NEW difficulty in interstate construction enterprises is presented by the differences that have arisen between New Jersey and Pennsylvania over collection of tolls on the soon-to-be-completed bridge over the Delaware River at Philadelphia. No progress appears to have been made in settling the differences since they first arose, nearly two months ago (*Engineering News-Record*, June 25, p. 1074, and July 2, p. 32). Pennsylvania (and even more so, Philadelphia, which is also a partner in the enterprise) insists that the bridge shall be free, and that it is bound by a no-tolls proviso attached to the latest legislative appropriation. New Jersey insists that tolls shall be collected, and that the vote of its citizens authorizing the issue of bonds for construction of the bridge and the actual issue of the bonds themselves were based on the expectation that tolls would be collected to retire the bonds. The situation appears to be deadlocked, until the legislatures act to clear it up.

Rather simple causes are at the bottom of the dispute. It is natural for Philadelphia to want free traffic over a bridge that is essentially a city convenience. It is natural for New Jersey, with its remote interest and its traditionally conservative financial system, to want tolls to retire the bonds, as in the case of the Holland tunnel under the Hudson River.

It is well to recall that taxation has largely ceased to be an attractive means of financing large public improvements. Under the pressure of post-war costs and overdue public needs there has been so general an upshooting of tax rates as to discourage further large drains on the current income of local government. Already in national and in state governments there are strong movements for retrenchment of expense and reduction of tax rates, and, although no similar movement is yet visible in cities and towns, the main creators of taxes, it is plain to every one that present rates are unpopularly high and that the chance of carrying out large construction work through tax moneys grows less favorable each year. This sentiment was a factor when New Jersey voted to join in the bridge undertaking, and it doubtless is a factor in the state's present adherence to the toll plan. In short, the issue is Taxes or Tolls.

One feature of the Pennsylvania-New Jersey case is that the probable traffic over the bridge is sufficient, with toll rates no greater than present river-crossing costs, to retire the whole investment in a short period of years. In so far as toll collection on the bridge traffic had been contemplated at all, the intention was to continue it only long enough to accumulate a sufficient retirement fund after meeting interest charges; it was not, we believe, intended to continue toll collections beyond such a period. The plan, in other words, was to build a bridge with the help of public credit, in response to the demands of those who wanted a better and quicker means of crossing the river than ferry, and permit these persons to refund the investment by continuing to pay crossing charges for a time. The superior service efficiency of the new facility was to be utilized to pay for its construction without placing a burden upon any one.

The issue of taxes or tolls which the case presents is of wide concern, and most particularly so in the case of improvements which possess demonstrably high productive efficiency. There is demand for many such public improvements, yet with taxes at their present height the people are slow to vote the necessary funds. Desirable works therefore have to be postponed, usually, with large indirect loss to the community as a whole and special loss to those who would be directly benefited. When the advocates of such an undertaking offer to prove that its direct benefits would greatly exceed its cost, the taxpayers are apt to remain apathetic, since they realize that these benefits go to a limited class, while the general taxable community must pay. A system that draws upon these benefits and yet utilizes public credit to provide the funds is therefore logical and attractive. Such a system also makes possible the development which results from the improved facilities provided by the undertaking—a development which otherwise remains dormant; and incidentally a share of the cost is (quite properly) collected from the beneficiaries of this development.

In its general nature, this system, which is that underlying the New Jersey financial plan for both the Philadelphia bridge and the Holland tunnel, is identical with the system under which most of our utilities, such as railways and street car lines, have been built and operated: the traffic pays for service rendered it, and the prospect of this service revenue is the only basis of credit for the enterprise. Much less public use has been made of the system, however, outside of certain special fields like water-works. In the old days of low taxes the service-toll system, in fact, was not thought of in connection with public bridges and other works having little or no operating expense. The new tax conditions, however, brought it into use here too, and such works as the Delaware River bridge, the Holland tunnel, the proposed New York Harbor bridges, and the Moffat railway tunnel, are being built or will be built on the service-toll retirement plan. The system has also had earlier extensive applications to municipal transit-line construction and has been seriously discussed for certain special highway improvements, such as the much discussed trucking highway across New Jersey. Appreciation of the system has steadily grown, and more extensive use of it is in sight, as a method of assuring rapid progress in public works despite tax-rate limitations. Should the system receive a setback at Philadelphia, this progress would be greatly discouraged.

One other point is significant in the Philadelphia situation. The bridge enterprise from the outset was mainly an engineering problem. All the hazards, and especially doubts as to timely completion, revolved around the actual construction work. This work is nearing completion, having been carried through with complete success and, in spite of many difficulties, without hitch or delay. The engineer has discharged his responsibility. Lawmakers and lawyers have done less well. It is through their failure that, on the eve of completion of the structure, the enterprise finds itself in a seemingly hopeless snarl.

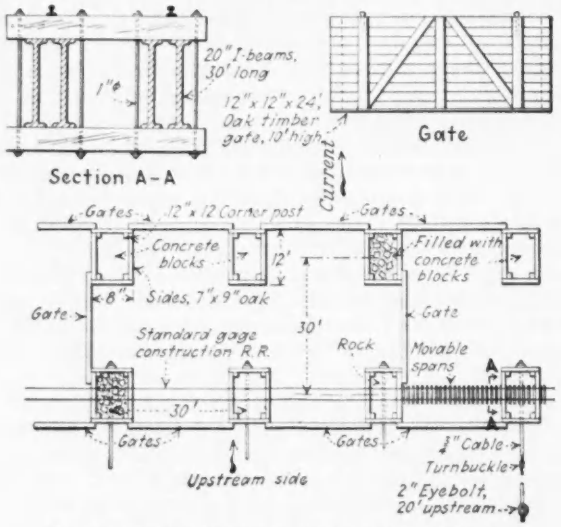
Grand River Crossing—Spavinaw Water-Supply Conduit

Cofferdams of Alternate Cribs and Wooden Gates Were Built on Smooth River Bottom—Temporary Tracks Removed During Floods—Precast Blocks of Concrete for Crib Filling

By W. R. Holway
Chief Engineer, Spavinaw Water Project, Tulsa, Okla.

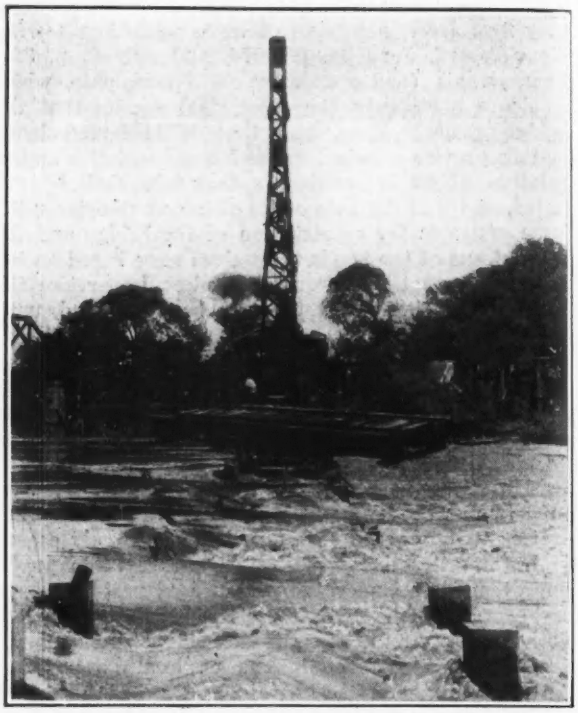
THE CHIEF construction difficulties involved in the laying of the 54-in. and 60-in. concrete pipe for the 55-mile gravity conduit of the Spavinaw Water Project came from the fact that this line had to be located across the lines of natural drainage which necessitated the crossing of seventeen large streams and rivers. Most of these crossings were made in the wettest season that Oklahoma has ever known. Excavation of the pipe trench in the smooth rock bottom was accomplished within a cofferdam made up alternately of cribs and gates. The upper cribs were rock filled and carried a railroad; the lower ones were removable and were filled with precast concrete weights. The gates were sealed with clay on canvas.

The largest of the rivers to be crossed was the Grand River, crossed at its junction with Spavinaw Creek about 5 miles below the Spavinaw dam. At this point the river is 800 ft. wide, has a smooth limestone bottom and varies in depth of water from 5 to 8 ft. at normal water level. The contractor's plan for this crossing was to build continuous log cribs, filled with rock, for two sides of a cofferdam. The standard-gage railroad which paralleled the whole pipe line also crossed the river at this point, and the plan was to build this bridge on log cribs filled with rock, spaced 14 ft. on centers, 30 ft. upstream from the center line of the cofferdam. Three times the contractor had 100 ft. of log cribs built out from the one bank of the river and each time the cribs were swept away by floods. The contractor's



COFFERDAM OF CRIBS AND GATES USED ON GRAND RIVER CROSSING

plan contemplated dividing the river into four sections, shutting off 200 ft. of the river each time. On abandonment of the pipe-line excavation contract by Walbridge-Aldinger Co., this river crossing was a portion of the work which the city was forced to take over and complete. Furnishing and laying the pipe was carried out by the Lock Joint Pipe Co., of New York. On Feb. 14, 1924, the date when the city of Tulsa began the work, 50 ft. of log cribs extended from the west bank into the river, but no other work had been done, either on the crossing or the bridge.



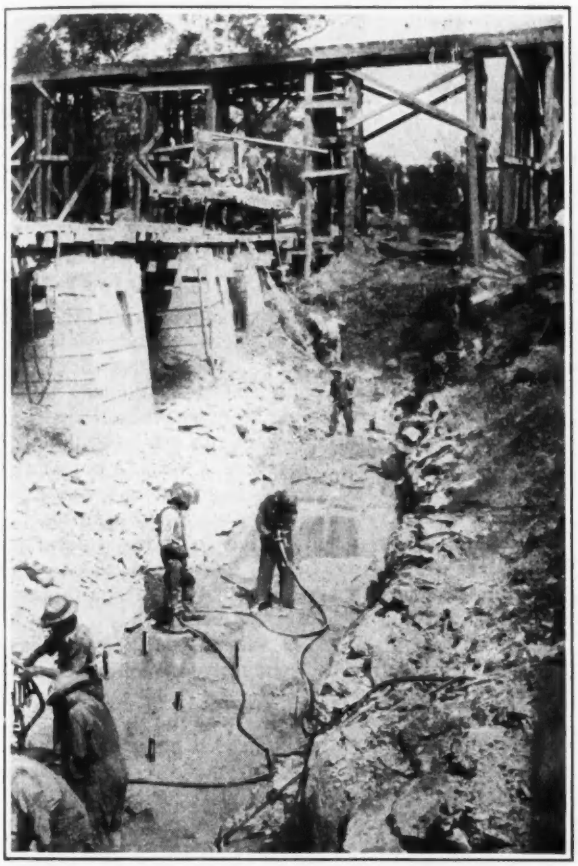
CRANE REMOVING BRIDGE SPANS ON APPROACH OF FLOODS

This work was in the direct charge of the engineers, and after consultation they decided—having a wholesome respect for this large river with its frequent floods carrying tremendous amounts of drift and débris—that a different plan should be adopted. The first piece of construction work was the building of a barge of native oak lumber 20x30 ft. in dimensions with a capacity of 30 tons. A stationary derrick was built on this barge. Across the river was strung a 1-in. cable, 30 ft. above the water, to which the barge could be anchored and along which it could work.

On the west bank of the river, above the high-water line, was placed a power plant with one 60-hp. and one 40-hp. boiler. A 350-cu.ft. per minute air compressor, a water tank, a machine shop and a blacksmith shop were also placed at this spot.

Work was started immediately on the railroad bridge. The plan adopted was to build this bridge with the rails 3 ft. above normal water and make it serve as the upstream side of the cofferdam. The piers of the bridge were made of 8x10-ft. timber cribs constructed of 7x9-in. oak timbers, drift-bolted to 12x12-in. oak corner

posts. These cribs were built on the barge, launched from it and placed by the derrick in exact position. They were spaced on 30-ft. centers, thus leaving a waterway between piers of 22 ft. After capping the cribs with 12x12-in. caps, 20-in. steel I-beams, 30 ft. long, four to the span, were then placed between the piers and the railroad ties were placed on the beams. The I-beams were firmly fastened together by placing a railroad tie under them, so spaced that there were four to each span. The ties above and below the steel



DRILLING IN EAST COFFERDAM WITH JACKHAMMERS
Air furnished by portable compressor on flat car hauled out on bridge spanning openings between cofferdam cribs.

beams were bolted together with four 1-in. bolts. The rails were laid so that the joints came opposite the ends of the I-beams, in order that each 30-ft. span could be lifted from its position in time of flood by simple unbolting the rails. After a span was completed, cars of rock were pushed out on it and the cribs entirely filled. Due to the smooth rock bottom and the swift current of the stream, it was found necessary to anchor each bridge pier to the rock. This operation was accomplished by drilling, from the barge, 2-in. holes, 20 ft. upstream, 4 ft. deep. In these holes steel eyebolts were set and wedged and ¾-in. cables carried from them around the corner posts of the cribs at water line. The cables were tightened with turnbuckles.

As fast as one span of the bridge was completed, the air line, the water line and the steam line were carried out. The air was used for the jackhammers in drilling the anchor holes and later in drilling the rock in the pipe trench. The steam line furnished steam for the pumps. The water line furnished priming water for the centrifugal pumps and cooling water for the gasoline engines.

After the bridge was completed and pipe trains operating, carrying the pipe across the river for the 4 miles of conduit east of Grand River, work was commenced on the cofferdam. Six timber cribs, made up exactly like the bridge cribs, were placed downstream opposite the first six bridge piers, on 30-ft. centers. A locomotive crane, operating on the bridge, filled each crib with precast concrete weights. Each weight was 2 ft. square and 10 ft. long, reinforced and with a heavy eyebolt running entirely through it. The weight of each was approximately 2 tons. These blocks were set on end and wedged in place to keep the crib from moving.

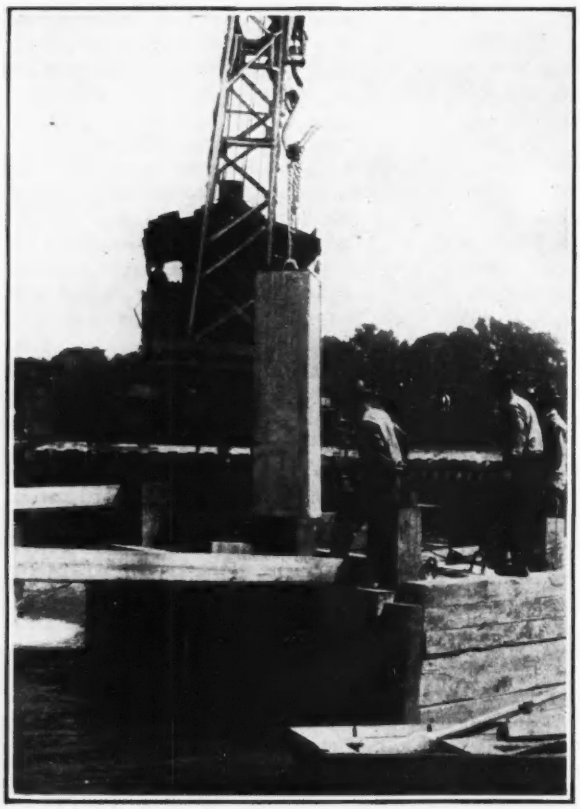
The next operation was the placing with the locomotive crane of the timber gates between each two cribs, both downstream, upstream and across the ends. These gates were made of 12x12-in. timber, 24 ft. long and built up 10 ft. high, so that each gate was 10x24 ft. in plan and weighed about 5 tons. They were fastened together by diagonal cleats and the joints calked with pitch to make them watertight. They were placed on the outside of the cribs so that each one lapped 1 ft. on a crib on each end. The upstream ones were held in place by the pressure of the water against them and the downstream gates by cables fastened to the bridge cribs; these cables were tightened by turnbuckles. Two gates, one on each side, were set 30 ft. beyond the end of each cofferdam, to deflect the current. Ordinarily, openings, either 60 ft. (two spans) or 90 ft. (three spans) were enclosed at one time. The longest cofferdam made was on the east end of the work, where 150 ft. was enclosed.

On the outside, 1 ft. from the bottom of each gate, a heavy 5-ft. canvas strip was nailed. After each gate was placed in position, men working in the water, sometimes in a diving suit, smoothed the canvas out along the bed of the river and placed sandbags on it, tightly pushed against the bottom of the gate. About 10,000 sandbags were thus used during the course of the work. After the bags had been placed entirely around the bottom of the cofferdam, clayey soil was dumped on top of the bags. On the upstream side this was done by side-dump cars. Downstream the material was placed either from the barge or by the locomotive crane using a clamshell bucket.

The unwatering of the cofferdam was accomplished by two 8-in. centrifugal pumps driven by gasoline engines, with a capacity of 1,500 gal. per minute each. The water was kept down while excavation was going on by a 6-in. pulsometer, a 4-in. pulsometer and smaller gasoline-driven pumps. The pulsometers were hung in the pipe trench from timber resting on the cribs. The gasoline-driven pumps were placed on the downstream cribs by the locomotive crane. On the west bank of the river, when the pipe laying started, a shaft was carried above ordinary water levels and one of the 8-in. centrifugal pumps located there permanently with the suction of the pump below the level of the bottom of the pipe. In this way the unwatering of cofferdams was made easy since it was possible to use the laid pipe as a sump, lowering the water level to the bottom of the pipe in the new cofferdam.

As soon as the cofferdam was unwatered, the jackhammers were started and the entire 60 or 90 ft. drilled, three rows of holes being used. Due to the

proximity of the cribs and the gates, light shots were used. The mucking of the rock was done by the locomotive crane operating a clamshell bucket. The rock was loaded into dump cars and taken to the river bank where it was dumped and later used for rip-rapping the banks of the river. After the trench had been completely excavated and brought to exact line and grade, the 60-in. concrete pipe, in 12-ft. lengths each weighing 7 tons, was brought out on the bridge on flat cars and was laid in the usual manner by the



PLACING REMOVABLE PRECAST CONCRETE WEIGHTS IN COFFERDAM CRIBS

locomotive crane. The joints were made the same as in the remainder of the conduit, namely, by calking of a wedge-shaped lead gasket from the inside of the pipe into a space left between galvanized steel bell-and-spigot rings.

After the pipe was laid in the trench, the concreting plant was brought out on the bridge and the space between the outside of the pipe and the walls of the rock trench was completely filled with concrete to restore the contour of the rock bottom.

The top of the pipe was in all cases at least 6 in. below the rock surface. The concreting plant consisted of three flat cars, one loaded with gravel, the one at the other end with sand and the one in the center with concrete mixer and the cement. The aggregate was moved from the sand and gravel cars by barrows. The storage piles of materials were on the bank of the river and the flat cars were loaded by clamshell bucket. Nearly 1,000 cu.yd. of concrete were used in this crossing.

As soon as the concreting was completed, one of the timber gates was placed inside of the cofferdam back

TEMPORARY BRIDGE ON UPSTREAM COFFERDAM CRIBS
After pipe was all hauled to east side of river, bridge removed as fast as pipe laid in trench to leave more free waterway. Portable compressor then furnished air for drilling.

from the end of the last pipe and against the end cribs; canvas and sandbags were placed while the cofferdam was still dry. As soon as this was done, the pumps were shut down, the cofferdam allowed to fill with water, and work immediately started on the next cofferdam. Empty flat cars were run on the bridge, the locomotive crane lifted the concrete weights out of the downstream cribs and placed them on the flat cars. The downstream cribs and gates were picked up by the derrick on the barge and floated to the new location, where they were placed by the locomotive crane. The crane again placed the weights in the cribs, the gates were again set and the operation repeated.

After the crossing was completed the pipe was connected at either end to the conduit by monoliths, heavily reinforced.

Altogether nine cofferdams were built. Only one was completed without being flooded out at least once. Reports of the coming floods were received daily from 100 miles up the river, and thus provision could be made for them. When floods were anticipated which would carry much drift, ten or more of the 300-ft. movable spans were lifted out complete by the locomotive crane and one by one taken to the shore and placed on the bank. As soon as the flood receded, the bridge spans were replaced. Several times the bridges

LAYING LAST PIPE IN GRAND RIVER CROSSING
Concrete weights fill cofferdam at right. End gate at center spans distance between upper and lower line of cribs.

were taken out with the flood waters lapping the wheels of the locomotive crane. About 300 ft. of the bridge was taken out and put back seven times in the course of the work.

The work was carried on in two 12-hour shifts with a force of about fifty men. Due to the floods the work was delayed again and again. The actual crossing took from April to October to complete and the cost was approximately $125,000.

Construction of the crossing was carried out under the personal direction of the writer. Dabney H. Maury was consulting engineer for the entire Spavinaw Project from the beginning of the preparation of the plans and specifications in 1922 to the completion of the work.

Driving Six-Mile Shimizu Tunnel on the Japan Railways

New Low-Grade Line to Replace Rack-Rail Grade of 6.6 per Cent in the Usui Pass—Methods and Progress

By Yoshiyuki Hashimoto
Engineer, Construction Bureau, Japanese Government Railways, Tokyo

THE Joetsu Line now under construction by the Japanese Government Railways is the shortest to connect Tokyo with the Uetsu District, which is rich in agricultural products. This line extends some 102 miles from Takasaki to Nagaoka, and will be about 61 miles shorter than by the existing Shinetsu Line of 163 miles between the same points. On the Joetsu Line there is now being constructed the Shimizu tunnel, more than six miles in length, through Mount Shigekura, 6,530 ft. above sea level. While the Shinetsu Line has a grade of 6.6 per cent with rack-rail at the Usui Pass, the new line will have maximum grades of 1 per cent, except for 2 per cent on the 25-mile section near the tunnel, where electric locomotives will be operated. The new line in connection with the Uetsu Line (opened in July, 1924) will bring about a great change in the traffic system over the majority of the districts along the coast of the Sea of Japan. At the Shimizu tunnel, 31,831.8 ft. in length, the mountain comes close to both entrances and in winter the snow lies well over 10 ft. deep in its vicinity, so that many difficulties were met with in making preparations for the tunnel construction. A map and profile are shown in Fig. 1.

Construction Equipment—Light railways of 2 ft. 6 in. gage were laid between Numata and Doai on the south side and between Yuzawa and Tsuchidaru on the north for transporting materials, machinery, supplies and food. Motor trucks and sledges were also used in co-operation with the railways. Electric current for operating the machinery is supplied by the Tokyo Dento Kabushiki Kaisha (Tokyo Electric Light Co., Ltd.); and substations, with maximum receiving capacity of 800 kw., have been erected at Oana (five miles from the south entrance) and at Tsuchidaru (near the north entrance).

For operating rock drills, mechanical muckers, hoists, drill sharpeners and other tools, five air compressors (446 cu.ft. per min.) have been installed at each portal. We have adopted several kinds of rock drills according to different conditions of the work, such as nature of rock, drilling methods, spots to be drilled; those so far employed include Sullivan, Denver, Leyner, Ingersoll, jackhammers, stopers and Ashio drills. At the drill-smithies, besides oil furnaces and sharpeners, lathes and several other repair tools have been installed.

Sand and gravel not being available near this tunnel, a stone crushing plant has been built at each entrance, with capacity of 10.5 tons of coarse aggregate and 2.5 tons of sand or fine aggregate per hour. As the prog-

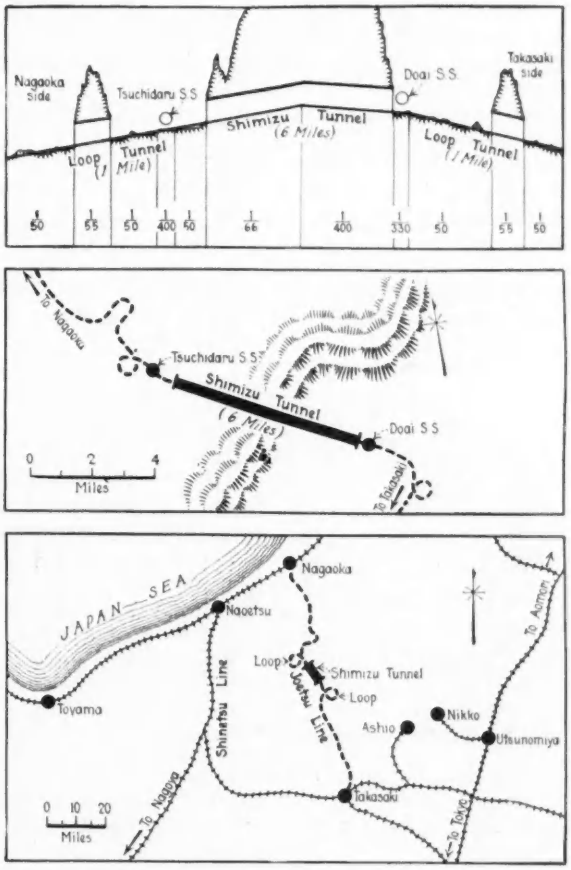


FIG. 1—JAPANESE RAILWAY WITH SIX-MILE TUNNEL

ress of excavation work necessitates ventilation, a turbo-blower with a capacity of 5,000 cu.ft. per minute is being installed and others will be installed as conditions require.

Rock and Headings—The rock excavated has consisted largely of diorite. Work was started in May, 1922, at the south entrance. For about 240 ft. the excavation was through loose material and was comparatively difficult, but since then it has been, for the most part, through hard rock and has been carried on very smoothly. A soft dislocation was encountered at about 2,330 ft. from the entrance. Work on the north side began in October, 1923. The rock was of nearly the same nature as that on the south side and the excavation has been carried on without difficulties worth mentioning, except on a section 1,400 to 1,500 ft. from the entrance, where a slight dislocation was found.

The length of heading driven by Jan. 15, 1925, was 3,162 ft. and 2,250 ft. on the south and north sides respectively. These figures are smaller than might be expected, which is due to the fact that the annual budget for the government undertaking has been reduced as

the result of the national calamity caused by the great earthquakes of Sept. 1, 1923. The rock excavated being of good nature for tunneling, the section on both sides has been made in the *A* type except near the entrance, where débris was found and the section of *B* type was adopted. The *A* type, with vertical side wall, was considered to expedite the mucking. These sections are shown in Fig. 2.

Methods of Heading Excavation—It will be seen from the foregoing that a somewhat bad soil was met with at the south entrance, so that the bottom heading method was at first adopted. But since reaching hard rock, this has been superseded by the bench method. In the latter system, the whole section is divided into three levels and the floor of heading 1 (see Fig. 2) is 12 ft. 9 in. above the formation level or subgrade. The bench is divided into two levels; the floor of heading 2 (higher level) being 6 ft. above the subgrade. This upper level is kept some 26 ft. from the end of the top heading, the timbering being taken into consideration. The lower bench 3 is kept so close to bench 2 as only to permit the rock drill to be mounted upon the latter.

Excavation has been done on a two-shift basis. Three

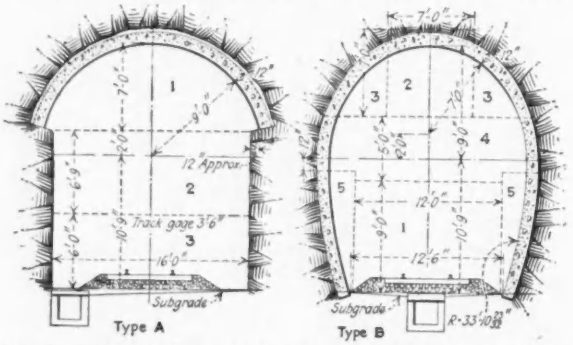


FIG. 2—TYPICAL SECTIONS OF SHIMIZU TUNNEL, JAPAN

rock drills are used for the heading, and the core boring is made in double V-cut or pyramid cut. The number of drill holes outside the heading is 25 to 30, with a depth of 5 to 6 ft. For the bench excavation, the drills and jackhammers are used. For ditching, jackhammers and Ashio drills are adopted. As explosives, blasting gelatine (nitroglycerine 90 per cent) is employed in the heading and dynamite of the Sakura brand (nitroglycerine 60 per cent) in other parts. Besides these, we are now making preparations to use liquid-air explosives.

For the excavation on the north side, the modern Austrian method has been adopted. Here the bottom heading (heading 1, Fig. 2), 9 ft. in height and 12 ft. in width, is driven on the formation level; then, with an interval of about 100 ft., the top heading (heading 2), 7x7 ft., is driven; then the cuts 3, 4 and 5 are driven successively, leaving an interval of 50 ft. in each cut.

At first, while the equipment was incomplete, regular progress could not be expected. But since arrangements outside the tunnel were put in order, the heading has been driven upon a three-shift basis and two rock drills have been used. The depth of drill holes, depending upon the hardness of rock to be excavated, is 5 to 6 ft. The core boring is made in V-cut and the number of drill holes is 25 to 30, dynamite of the Sakura brand being used as the explosive. For the top heading and other enlargement work, jackhammers and Ashio drills are adopted.

Mucking—Steel plates are laid on the floor before blasting for the heading, the muck from the heading being deposited upon them. On the south side, the muck is carried to the bench by hand barrows, or by scrapers hauled by a hoist. At the front end of the floor of the heading is laid a horizontal bar to which an iron chute is attached. The muck comes through this chute into tunnel cars, independently of the muck from the bench. The muck from the bench (or from the whole section when removed by the hand barrows alone) is delivered to iron cars of 40 cu.ft. capacity by two mechanical loaders. To expedite the mucking, double track is laid inside the tunnel, with one crossover a little ahead of the spot of the last lining, and a scissors crossing is fitted up a little behind the bench under excavation.

On the north side, the muck from the bottom heading is loaded by a mechanical mucker into wooden barrows of 20 cu.ft. capacity, each of which is operated by two men. The muck from headings 3 and 4 is taken into trucks through the chute which is driven at a convenient spot of the bottom heading. On the full section, where the lining and side ditching are being done, single track is laid with double track beyond. While at present the muck cars are moved by hand, both on the south and north sides, preparations are being made for operating electric locomotives.

Timbering—On the south side, because of very hard rock excavated, timbering has so far not been used, except at the spot of soft soil near the entrance and at the dislocation some 2,330 ft. from the entrance. But timbering with iron rafters or stringers is intended to be made, if soft strata should necessitate it. On the north side, timbering with pine logs has been used for the greater part, because of soft soil conditions.

Lining—As to the lining of the *A*-type section, the arch is lined with concrete blocks and the side lining is made with 1:3 grout blown by cement guns to the thickness of one inch. The arch center used in the lining is of traveler type, 36 ft. in length, and moves on 30-lb. rails laid close to the side walls.

Employees and Progress—The number of employees now engaged in the tunnel construction is 250 and 400 on the south and north sides respectively. Arrangements for lodging, water systems, sewers, infirmary, school, bathing-place, etc., have been perfected. Now that the equipment for the work both inside and outside the tunnel has been put in order, progress on both sides together can be expected to be 20 ft. per day, so that this six-mile tunnel should be completed by the end of 1928, when the whole Joetsu Line will be opened to traffic. All the tunneling work is done directly by the Japanese Government Railways, no contractor being employed.

New Railway to Be Constructed in Australia

Specifications are now under preparation prior to the calling of tenders for the construction of a railroad from Kyogle, New South Wales, to South Brisbane, which is to form a part of the uniform gage scheme. It is estimated that the work will involve an expenditure of $16,800,000. Of this amount the federal government will subscribe $9,600,000; New South Wales, $5,300,000; and the Queensland government, $1,900,000. In connection with the building of this railway line, it will be necessary to bridge the Clarence River, which, it is estimated, will cost $2,400,000 and will be carried out by the local state government.

Engineering in the Small City

A series of notes from the field on the Problems and Practices of the Municipal Engineer in the Cities Below 100,000

The Editor Visits the City Engineer

Snapshots of Our Representative Small Cities

Nashville, Tenn.

FULL-SIZE REPLICA OF PARTHENON—NASHVILLE, TENN

STATE CAPITAL AND COUNTY SEAT OF DAVIDSON COUNTY, 186 miles by rail southwest of Louisville, Ky., and on the Cumberland River, largely on hilly ground. Has large flour and feed mills, printing and publishing houses, lumber and other industries, and is seat of many educational institutions. The replica of the Parthenon (sketched above) is located in Centennial Park. It is built of reinforced-concrete, to the size and dimensions of the original. Nashville was settled and incorporated in 1784; chartered as a city in 1806. Pop. (est. 1925) 125,000, so that it does not come strictly in the class delimited by the title of this series.

IN NASHVILLE, Tenn., all engineering design and construction, except that for parks and water-works, is under the direction of the city engineer, who serves in an advisory capacity only on water-works problems. With the operation and maintenance of the works built by himself the city engineer has nothing to do, except general co-operation with those in charge and with the mayor, who is chief executive officer of the city. Street maintenance is under a street superintendent, directed by the mayor. A superintendent of street cleaning and scavenging, under the board of public works, has charge of sewer maintenance, street cleaning and sprinkling and the collection and disposal of ashes and refuse and of the relatively little garbage collected by the city.

The staff of the city engineer (May, 1925) includes a first and a second assistant, each of whom has a corps of four men—an instrumentman, rodman and two chainmen. The first assistant has charge of the field work and the second assistant co-operates with the first. The remainder of the staff consists of a draftsman and two assistant draftsmen, these three attending to all office work, and a stenographer and clerk combined. Of the 13 men on the staff 4 are engineers. In addition there are 3 inspectors of construction work.

The city engineer and his staff are appointed by the board of public works, and after a probation period of three months can be removed for cause only, subject to the approval of the civil service commission—which does not conduct civil service examinations.

Construction work is done by contract except on failure to obtain satisfactory bids, when the board of public works may direct that the work be done by force account under direction of the city engineer.

An unusual scheme of government now prevails in Nashville. In 1914 a change was made from a mayor, a council of ten members elected at large, and a board of public works, to the commission plan, with four members. This lasted until 1920 when the legislature provided for a mayor-manager, a city council of 13 members (elected one by each ward) and reconstituted the board of public works, comprised of the city engineer, superintendent of water-works, superintendent of light plant and the health officer. In 1923 the present scheme came into use: A mayor who is the chief executive of the city, and responsible for administration, except as he shares administrative powers with his fellow members on the board of public works; a council of 25 members, elected one from each ward and serving for two years; and a board of public works consisting of the mayor and two other members, all elected at large for four years.

The city engineer is subject to the direction of the mayor and board of public works. The board initiates all public improvements except parks but including water-works. Its recommendations, in the form of resolutions, go to the city council for approval and for appropriations. The council must act on all recommendations thus submitted to it and may veto any recommendation by refusing money to carry it out but it cannot alter the plans by direct action.

The water-works is under the board of public works, in direct charge of an engineer-superintendent. The board has no control over parks, which, by a supreme court decree, since embodied in the city charter, are in charge of a park board, which nominates its own members when vacancies occur, subject to approval by the city council. This board has its own engineer and has absolute control over its own expenditures, though without power to levy taxes. This unusual condition resulted from a citizen's lawsuit brought some 25 years ago to annul the street railway franchise for alleged invalidity. The suit was compromised on agreement of the railway to pay the city 3 per cent of its gross receipts, to be devoted to the acquisition, construction and maintenance of parks, the fund and the parks to be administered by the board as already outlined.

With the exception of parks, education, hospitals and a humane commission the entire affairs of the city are administered directly by the mayor and board of public works. The members of the board of education are appointed by the mayor and confirmed by the council and the council also controls the appropriations for the board and salaries paid by it. In fact, the council controls all expenditures, except for parks, by a budget system. The charter makes it the duty of the "Mayor and City Council" to "agree upon a budget" after the "Board of Public Works shall have submitted its estimate" for the next year's salaries and other current expenditures.

A bonded indebtedness limit of 10 per cent of the assessed valuation is fixed in the charter but there is no tax limit except that effected by public opinion.

The first cost of practically all pavements is divided between the city as a whole and abutting private property. All street intersection cost and one-third of the remaining cost is met by the city, the other two-thirds of this remainder being assessed on abutting property on a pro rata frontage basis. Initiation of pavements may be either by petition of the owners of two-thirds of the abutting frontage, which becomes a mandate on the board of public works or else by the board itself, subject to the approval of the city council. The "mandate" just mentioned is always accepted by the city

council although possibly it could refuse to take the necessary action to put it into effect. The first cost of pavements is met by bond issues, which are a lien on the abutting property (up to the amount only of that part assessable to owners and subject to a guarantee by the city). The charter prohibits the letting of any city contract unless the money to pay for it is in the city treasury.

The cost of curbs and sidewalks and gutters is met by funds derived from a rotating bond fund. Property owners are notified by publication in a daily newspaper specifying character of work and affording lot owners 30 days after publication in which to comply therewith by private contract. In event of failure to comply then the board of public works receives formal bids for the specified work for all lots whose owners have failed to comply, and lets the contract therefor to the lowest responsible bidder and pays therefor out of the rotating bond fund. The cost of curbs, sidewalk and gutters, as the case may be, is charged against the respective lots and owners and becomes a lien upon the property so affected, enforceable by a bill in equity, including interest at 6 per cent and all incidental costs. When the charges are collected they are restored to the rotating bond fund for reuse.

The three main types of pavement used in Nashville are Kentucky rock asphalt, bituminous asphalt after the Topeka specification, and Durax granite blocks, the latter on heavy traffic streets. Probably twice as much Kentucky rock asphalt is used as the other two kinds combined. No brick or wood has been used for several years. Concrete base is rarely used, chiefly because most of the new pavement is put down on old telford-macadam which needs only to be scarified.

The cost of sewers is met by bond issues, not by assessments. There will be a referendum vote next fall on a $1,000,000 sewer bond issue, to pay for extensions into newly annexed districts.

The sewers of Nashville are on the combined plan: Vitrified clay pipe for less than 30 in. diameter and a good local brick for sewers of 30 in. and upwards, the largest being 16½ ft. Self-cleansing velocities are almost always easily obtainable, on account of the hilliness of the city, but on the bottom lands near the river there are some low grades—0.2 per cent for one 10-ft. diameter sewer. On sewers with diameters of 12 in. or less and grades of less than 1 per cent flush tanks are used. Sometimes the grades of these are also as low as 0.2 per cent.

The city has no topographical map and the need of one is keenly felt. Within the older part of the city lines of levels run from time to time as streets and sewers were built serve fairly well but there are few such lines in the annexed territory. There is no official map of the city. A city planning and zoning commission will soon be created in accordance with an enabling act passed by the 1925 legislature.

Although the city collects ashes and rubbish there is no municipal collection of garbage except in the business district. Street sweepings, rubbish and ashes are used for filling purposes on the nearest available land. Hog owners collect garbage at will throughout the residence districts.

W. W. Southgate has been city engineer of Nashville since May 6, 1901. He was appointed by the board of public works of that time, to serve during good behavior, and has remained in office without reappointment during all the changes in form of government and in administration. The position is one prescribed by charter many years ago. Before his appointment Mr. Southgate was in private engineering practice. He grew into engineering under his father, who was an engineer. Charles W. Wain is assistant engineer and J. C. Evans is chief draftsman.

Engineering Work

Features of Newark, Ohio, Water Softening Plant

By Clarence T. Kaiser
Chemist in Charge, Newark, Ohio

SPLIT treatment of chemicals, a weir box provided with Sutro weirs, replaceable concrete slabs at the water line on the baffle boards of the settling basins, a Dorr clarifier for continuous sludge removal, and carbonation are features of the 6-m.g. water softening and purification plant recently put in operation at Newark, Ohio, at a cost of approximately $250,000.

The plant is provided with two baffled mixing tanks allowing water to flow over and under and around the ends. One-hour retention period is provided for when pumping 6 m.g. of water. Principal components of the plant are: Two settling basins having an eight-hour retention period; four mechanical filters with a rated capacity of 1.5 m.g.d.; a small clear-water reservoir (the main reservoir is located at a high elevation and supplies water to the consumers by gravity); a 50,000-gal. wash-water tank; a chlorinator; two dry feeding machines for alum and two feeders for milk of lime, all four automatically controlled from floats in the weir box; and two lime storage bins, each holding a carload of lime. The lime is unloaded from the cars by a power shovel, elevated to the bins and discharged by gravity through weighing scales into slackers and then into chemical solution tanks and applied to the water by means of milk of lime feeders. Additional storage space for four or five carloads of bagged alum and soda ash is provided. This storage room is on the level of the floor of a box car when standing on the track adjacent to the plant, and the chemical feeding machines, being on the floor below, make it unnecessary to elevate the alum in the soda ash.

Split Treatment of Chemicals—In order to reduce the hardness of water high in magnesium salts to the lowest possible degree, it is necessary to use an excess amount of lime, then neutralize the excess lime with soda ash, leaving residual or excess sodium hydroxide in the treated water. This practice is successfully followed for softening water for boiler feed purposes and for laundry work. At Newark it was decided to overtreat a portion of the water and then neutralize the overtreated portion with raw water. This practice we label "split treatment." The water is first pumped into a weir box provided with 6 weirs and the water can be divided into almost any desired portions.

Replaceable Concrete Slabs on Baffle Walls—Solid concrete baffle walls built in open settling basins if in a cold climate usually become badly spalled at the water line and the top 2 ft. of the walls sometimes even go all to pieces. In order to be able to repair easily the damage from ice and freezing, the baffle walls at

Of the Small City

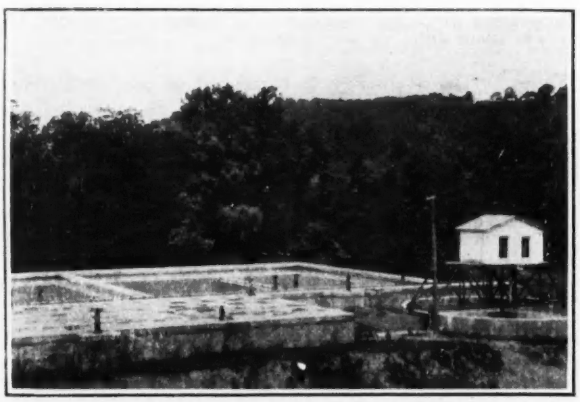
Newark are built of solid concrete to within 2 ft. of the top and into this solid concrete wall are embedded H-shaped (in cross-section) iron castings 4 ft. long, 2 ft. embedded in the concrete and 2 ft. projecting out of the top of the wall. These castings are spaced 6 ft. apart and form grooves into which are fitted reinforced-concrete baffle boards 2 in. thick, 2 ft. wide, 6 ft. long. They can be replaced if damaged.

Clarification—The retention period in the clarifier is 22 minutes when pumping 6 m.g. in 24 hr. Results of operation of the clarifier pumping at a rate of 3 m.g. per 24 hr. follow:

SUSPENDED SOLIDS

Sample	P.p.m.
1. Dorr feed	478
2. Dorr effluent	22
3. Settling basin effluent	4
4. Dorr clarifier, 6 ft. below surface	206
5. Dorr clarifier, 9 ft. below surface	800
6. Dorr clarifier, 12 ft. below surface	830
7. Dorr clarifier discharge	20,108

It will be noticed from these results that 95.4 per cent of the solids are removed in the Dorr clarifier and that 96.2 per cent of the settleable solids are removed. At the time this test was made the discharge was opened too wide and the sludge was too wet. Since this test was made it has been possible to obtain a result of more than 98.5 per cent of settleable solids removed.



SETTLING BASINS AND CLARIFIER—NEWARK PLANT

Advantages of the clarifier are: (1) The discharge of sludge continuously and in small quantities into a small stream does not create a nuisance as it does when held for a period of two, three or four weeks and then discharged all at once. (2) The period of retention in the settling basins is not being diminished each succeeding day by the accumulation of sludge. In other words, the full capacity of the settling basins is available for sedimentation purposes instead of their being storage reservoirs for sludge. (3) It is possible to build this type of tank below the level of drain, that is if the sludge is pumped.

Carbonation—The carbonation plant consists of a steam-driven, reciprocating gas compressor, taking its suction through a dryer and scrubber from the breeching of the boilers and forcing the scrubbed and dried gas through diffusers located in the settling basins near the outlet. The diffusers consist of perforated pipes; very good distribution is obtained, with no clogging.

The diffuser is made by surrounding a perforated pipe with cemented sand, the cemented sand being made from twelve parts of coarse screened sand and one part of cement. The base and top are made from rich concrete in order to give strength to the leaner mixture.

River Current and Tidal Flow Studies Determine Sewer Outfall Position

INASMUCH as the city of New London, Conn., is situated at the mouth of the Thames River, sewage disposal becomes a matter of the placement of outfalls far enough into the river to assure the sewage being carried by river current and tide into Long Island Sound. At the present time there are six outfalls and each is built up of wood sections, banded together with steel rods secured by saddles and turnbuckles. Some of these outfalls have been in more than 20 years yet there is no deterioration from sea water or teredos.

When the approximate position of the outfall has been determined, float observations are made in a line normal to the bank of the river. A bottle is plugged at the mouth and a red flag inserted in the plug. The flag is of sufficient size so that a transit can easily pick it up at a quarter of a mile from shore. The bottle carries a weight sufficient to submerge it.

At each end of a base line on shore a transit is placed and angular measurements are made of the course of the flag. Observations are made at intervals of about one minute extending over a period of about half an hour, unless adequate information as to the current and tidal flow can be secured in a shorter time.

Observations are made first with the weight suspended immediately under the bottom of the bottle. When these have been completed another set is taken with the weight suspended 7 ft. from the surface and a third set with the weight 20 ft. from the surface of the water. From these various observations can be determined that point in the river nearest the shore at which the outfall can end, without any fear of the sewage finding the shore line.

Washed Gravel vs. Crushed Rock in Concrete

Under direction of the city engineering department of Fort Worth, Texas, tests were recently made of 200 concrete cylinders, half using washed gravel and half using crushed Chico stone. The gravel was from nearby deposits in the flood plain of a fork of Trinity River, which are the result of erosion of the rocks of the Lower Cretaceous (Comanchean) Period; the pebbles are hard and sound but their surfaces when magnified show countless minute pits. There were two mixes of concrete, 1:2:4 and 1:2½:5. After molding, the test cylinders were placed in damp sand and sprinkled daily. After 90 days, on crushing the washed gravel cylinders showed strengths of approximately 3,700 and 3,400 lb. per sq.in. for the two proportions and the crushed rock 2,700 and 2,050 lb. The superiority of sound washed gravel over sound crushed stone is ascribed partly to the fact that the facets of the crushed stone are glassy whereas the surface of the gravel pebbles is rough and pitted, also to the smaller percentage of voids in the gravel aggregate. These tests were described by John A. Hawley, consulting engineer, in a paper before the Texas Section of the American Society of Civil Engineers. Mr. Hawley performed the tests, with C. B. Collard, principal assistant city engineer, Fort Worth. Dudley L. Lewis is city engineer there.

Eliminating a Highway Bottleneck in New Jersey

Half-Mile Cutoff Improves Grade Alignment and Removes Grade Crossing With 130 Train Movements Daily

A ROAD change which gives several additional traffic hours a day on a heavily traveled highway from the New York metropolitan district to the New Jersey coast resorts has recently been completed near South Amboy. This improvement, locally known as the Morgan cutoff, eliminates a tortuous line, a steep hill and a grade crossing on a busy railway. The new line is only 2,550 ft. long but, excluding the bridge over the railway which was built by the railway, its contract cost was $103,307. It is largely a plain earth fill made with teams and without an unusual method or machine employed in the construction. Yet the road is an outstanding improvement because by its construction an obstacle and a hazard to traffic are

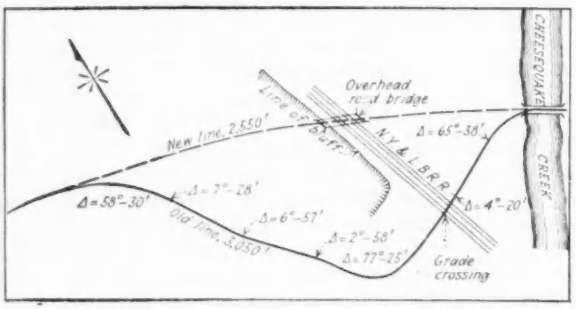


FIG. 1—SKETCH MAP OF MORGAN CUTOF AND OLD ROAD

removed. It also exemplifies high state standards in highway structures.

Traffic Conditions—From Jersey City and Newark to Asbury Park is the most heavily traveled road of New

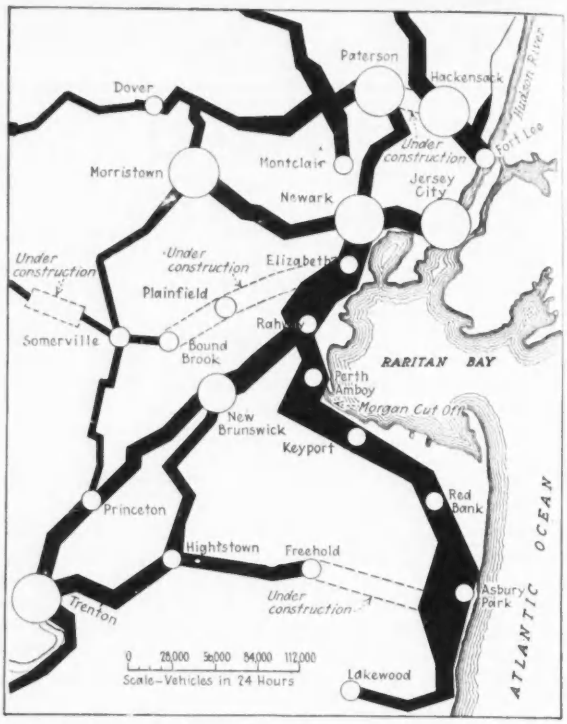


FIG. 2—NEW JERSEY TRAFFIC MAP—METROPOLITAN DISTRICT TO COAST RESORTS

Travel on the shore road is the heaviest of any New Jersey highway of similar length. Arrow shows where bottleneck was eliminated.

Jersey. The area, Fig. 2, taken out of the latest traffic map of the state, indicates clearly the heavy black ribbon of resort travel up and down the coast. At the place on this ribbon to which the arrow points was the tight spot. Here, near the little hamlet of Morgan, the road, swinging inland from the shore, crossed the salt marsh skirting Raritan Bay, the drawbridge over the Cheesequake River, the double tracks of the New York & Long Branch R.R., and twisted around and

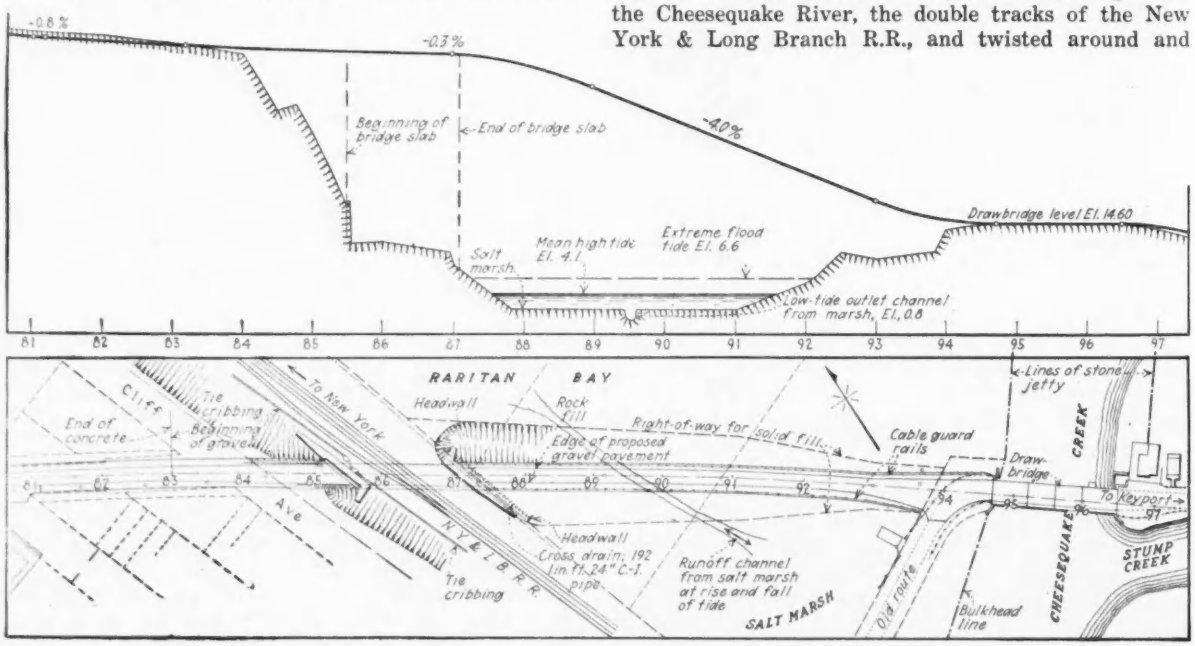


FIG. 3—PLAN AND PROFILE OF HEAVY CONSTRUCTION ON MORGAN CUTOFF

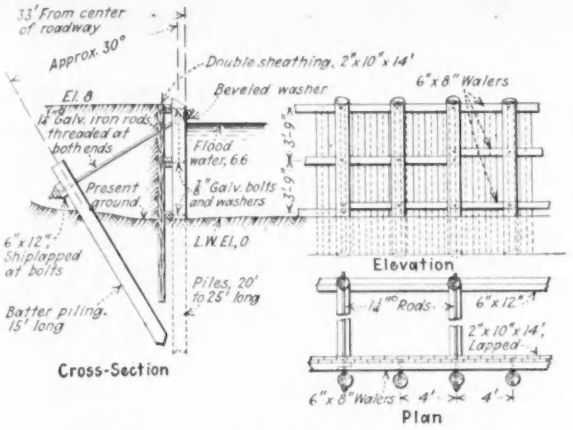


FIG. 4—BULKHEAD HOLDING ROAD FILL FROM TIDE WASH

climbed the bluff on its way to South Amboy. The line is indicated by Fig. 1.

Traffic counts at Morgan during the summer show 18,000 vehicles in 16 hours, and 1,500 an hour. These are peak records. But probably during the shore resort season there is never a daily vehicular movement below 10,000. At other seasons the flood lowers, but even in winter several thousand cars a day pass the Cheesequake bridge. This traffic has all had to take the curves and the steep hill at Morgan. More significant than this it has had to halt for every train movement at the railway crossing. A count showed some 150 train movements daily. The traffic delay for each ranged from 45 seconds to 2 minutes. It averaged about 1 minute. Adding secondary delays caused by halt, as stalled engines, small collisions and interference, the delay per day due to closed crossing gates was fully 3 hours. This has been eliminated by the new line as of course has all hazard of train collision. With the route shortened 500 ft., a flatter grade and virtually no curves it is not extravagant to count a 25 per cent increase in traffic capacity by the construction of the new cutoff.

Road Structures—The large construction operations were the 75,000-cu.yd. earth fill and the concrete bridge over the railway. Their location is shown by Fig. 3. The bridge being a separate operation conducted by the railway is only mentioned in passing. The fill only is of particular interest and largely because it crosses a tidal marsh and involves special structures to meet the condition of tidal flow. The plan and profile of Fig. 3 indicate the water conditions. The fill makes virtually a dam across the marsh neck between the drawbridge and the railway which formerly offered a free way for tidal flow.

As stated before, the embankment is a wagon fill of material borrowed from the bluff north of the new crossing and west of the railway. Its special structures to meet the conditions of tidal flow were a rock fill 8 ft. high on the bay slope, a drainage conduit through the fill and a timber bulkhead about 400 ft. long of the

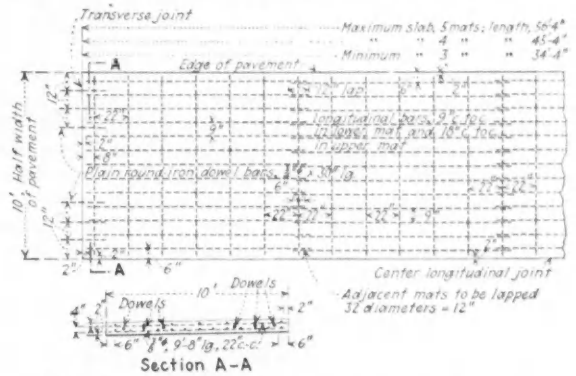

Transverse joint
Maximum slab, 5 mats; length, 56'4"
" " 4 " " 45'4"
Minimum " 3 " " 34'4"
Edge of pavement
A
10' Half width of pavement
12"
Long. reinforcement, 2 bars, ⅜" ϕ, 10' long, 3" from upper mat
Plain round iron dowel bars, 1" ϕ, 30" lg.
2"
6"
Center longitudinal joint
Adjacent mats to be lapped 32 diameters = 12"
10' Dowels
4" 2" Dowels
2"
<6" ⅜" ϕ, 9'-8" lg., 22" c-c <6"
Section A-A

FIG. 5—STANDARD CONCRETE PAVEMENT SLAB

design shown by Fig. 4, east of the drawbridge where Stump Creek washes the embankment. Details of the bulkhead are amply clear from Fig. 4.

As shown by Fig. 3 the cross drain is located just back of the east abutment wall. Here it could be carried on T-rail brackets set in the wall and escape

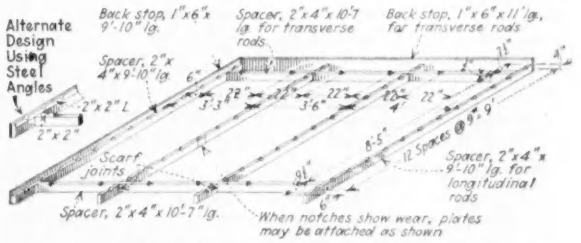

Alternate Design Using Steel Angles
Back stop, 1"x6"x 9'-10" lg.
Spacer, 2"x4"x 10'-7 lg. for transverse rods
Back stop, 1"x6"x11'lg., for transverse rods
Spacer, 2"x 4"x9-10" lg.
2"x2" L
2"x2"
Scarf joints
12 Spaces @ 9"
Spacer, 2"x4"x 9-10" lg. for longitudinal rods
Spacer, 2"x4"x 10'-7" lg.
When notches show wear, plates may be attached as shown

FIG. 6—FRAME FOR FABRICATING STEEL ROD MATS

any hazard of embankment settlement. It is 24-in. cast-iron pipe with simple headwalls of concrete and at the north or bay end an automatic tide gate, which closes against the tide inflow from the bay and opens for the back flow from the marsh. The rock on the bay side of the fill is virtually a riprap slope cover about 2 ft. thick of stones larger than 1 cu.ft.

Paving and Fencing—A concrete pavement is planned. On the fill, however, a gravel surface is laid

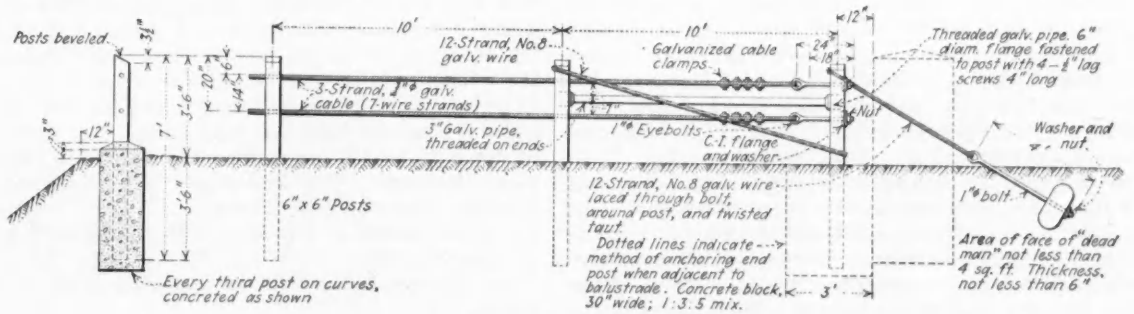

Posts beveled.
10'
12-Strand, No.8 galv. wire
Galvanized cable clamps
Threaded galv. pipe, 6" diam. flange fastened to post with 4—½" lag screws 4" long
3-Strand, ¾" ϕ galv. cable (7-wire strands)
3" Galv. pipe, threaded on ends
1" ϕ Eyebolts
C.I. flange and washer
Nut
Washer and nut
12-Strand, No.8 galv. wire laced through bolt, around post, and twisted taut
1" ϕ bolt
6"x6" Posts
Dotted lines indicate method of anchoring end post when adjacent to balustrade. Concrete block, 30" wide; 1:3:5 mix.
Area of face of "dead man" not less than 4 sq. ft. Thickness, not less than 6"
Every third post on curves, concreted as shown

FIG. 7—STANDARD WIRE ROPE GUARD RAIL

until the embankment has settled and consolidated. West of the fill as indicated on Fig. 3 the standard concrete pavement will be put down. This is a high type of structure and as exemplifying state practice is illustrated in some detail by Figs. 5 and 6. This design shows the slab dimensions and arrangement of reinforcement for the standard 20-ft. pavement. Where the width differs from 20 ft. the same general arrangement is required but the lengths of the transverse bars and the number of longitudinal bars are increased or decreased so as to retain about the same spacing. A particular requirement is that the two layers or bars shall be so connected by ties and separators that they form a rigid mat that will not collapse when the concrete is placed and tamped. Fig. 6 shows the frame for fabricating the reinforcing mats. It is set on low horses so that the men can step inside and work.

On the work being described a 1:1¾:3½ concrete was employed and placed in two layers according to the following specification:

> After mixing the concrete shall be deposited at once in successive batches upon the subgrade, then immediately distributed over the entire width between forms and struck off to a uniform depth of 2 in. above subgrade.
>
> After the reinforcement has been placed on the layer of concrete thus laid, the remainder of the concrete shall be deposited and evenly distributed so that the resulting surface is fairly uniform in character and sufficiently above the required pavement surface that after being properly struck off, it will not be compressed below the grade specified therefor.
>
> The amount of the bottom layer placed at one time shall not be greater than that which can be covered by the reach of the mixer boom in placing the top layer. In no case shall the mixer travel over the bottom layer of concrete and care shall be exercised that walking thereon shall be only such as is necessary properly to place the reinforcement.
>
> Any portion of the bottom layer of concrete, which has developed initial set or which has been in place more than 30 minutes without being covered with the top layer, shall be removed and replaced with newly mixed concrete.

The state standard wire rope guard rail is shown by Fig. 7. In this design the anchorage methods and end panel construction are to be particularly noted.

Direction—The work described was carried out under the direction of the New Jersey State Highway Commission, W. G. Sloan, state highway engineer. The contractor was S. S. Thompson, Red Bank, N. J. Construction was begun Oct. 30, 1924, and the road was open for traffic July 3, 1925.

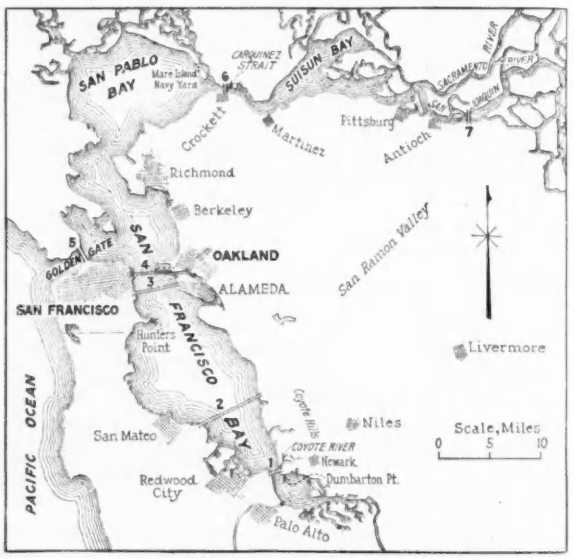
California Changes Concrete Girder Bridges

Adoption of two-girder construction instead of the four-girder construction which has heretofore been standard in the concrete girder bridge work of the California Highway Commission involves a considerable economy in cost, according to Harlan D. Miller, bridge engineer of the commission. The first bridge of the new type has been built over the San Lorenzo Creek at King City, Monterey County. It is 240 ft. long, consisting of three 60-ft. girder spans and two 30-ft. girder spans. In each span the two girders are spaced 11 ft. c. to c. and carry an 11½-ft. roadway slab. The roadway is 21 ft. wide, its outer portion being cantilevered beyond the girders. The cost of the structure was $40,000, which represents a saving of about 15 per cent over a four-girder structure. The girders in the 60-ft. span are 29x64½ in. in cross-section.

The San Francisco Bay Bridge Situation

Three Bridges Under Construction, Numerous Projects Suggested and Widespread Public Interest in Bay Bridge Plans

SITUATED on the tip of a narrow peninsula, San Francisco has, since automotive traffic began to grow heavy, felt an increasing need for highway bridges to provide easy means of access to suburban districts. In response to this popular demand three highway bridges over San Francisco Bay or adjoining tidewaters are now well under way, four projected bridges are definitely up for consideration and numerous propositions in less definite condition are receiving more or less publicity and attention. On the occasion of a War Department hearing of bay bridge proposals 3½ years ago, *Engineering News-Record* published (Nov. 3, 1921, p. 739) a table listing 13 crossings that were proposed at that time. A résumé of some of the more definite projects that have been officially consid-



PROPOSED BRIDGE LOCATIONS, SAN FRANCISCO BAY

ered within recent weeks is given in the accompanying table.

One of the most important factors in any of these bridge projects is the attitude of the United States War Department, as repeatedly stated in letters to applicants for bridge permits or to city officials. The War Department has persistently reiterated the policy first announced in a letter dated Dec. 1, 1921, stipulating just what conditions would govern approval of proposed San Francisco Bay bridges. As recently as the middle of May of this year a letter to the San Francisco board of supervisors, signed by Gen. Edgar Jadwin, Engineer Corps, U.S.A., stated that there was no apparent reason for making any change in the previous decisions. The limitations prescribed by the War Department are as follows:

(1) No bridge of any kind will be approved north of Hunter's Point.

(2) No low bridge will be approved north of San Mateo.

(3) A tunnel would be approved at any location if

SOME SAN FRANCISCO BAY BRIDGE AND TUNNEL PROJECTS

Map No.	Builders or Proponents	Engineers	Type of Structure	Location	Channel Crossing	Other Main Spans	Roadway Width No. of Tracks Total Length of Crossing	Estimated Cost, Dollars	Present Status of Project	Remarks
1	Dumbarton Highway Bridge Corporation	J. L. Harrington	Steel truss and concrete pile trestle	¾ mi. N. of present R. R. bridge at Dumbarton (32 mi. from Golden Gate)	200 ft. lift span	Nine 228 ft. steel spans	24 ft. No R. R. tracks 6 mi.	2,000,000	Under construction, to be completed this fall	.....
2	Frank E. Webb	.....	Concrete viaduct	9 mi. N. of Dumbarton R. R. bridge (23 mi. from Golden Gate)	200 ft. lift span	28—200 ft. concrete arches	40 ft. No R. R. tracks 7.07 mi.	10,000,000	Franchise and War Dept. approval secured; former lapses soon if work not started	New proponents waiting to apply if franchise lapses
3	Bay Cities Bridge Co.	J. G. Little	High level steel trusses	16th St., S. F., to Pacific Ave., Alameda	One 1,000 ft. span Two 590 ft. spans	48—250 ft. steel trusses	38 ft. B. and C. inc. tracks 27,750 ft.	A—20,000,000 highway B—30,000,000 highway and El. Ry. C—50,000,000 highway Elec. and steam R. R.	Hearing before S. F. Supervisors, June 22	Have plans for bridge and tunnel if high bridge not approved
4	James Marwick	Davies and Modjeski	Tube and steel spans	From pier 28, S. F., to S. P., Oakland Mole	7,400 ft. tube on S. F. side	14—300 ft. spans* 20—300 ft. spans** 1—1,000 ft. span‡	40 ft. on bridge 21 ft. in tube Two El. Ry. tracks: 18,600 ft.	60,000,000	Hearing before S. F. Supervisors, June 17	.....
5	J. B. Strauss	J. B. Strauss	Combined cantilever and suspension	Across Golden Gate	4,000 ft. span, 200 ft. above tide level	Two 1,345 ft. approach spans	52 ft. Two El. Ry. tracks 6,640 ft.	30,000,000 including highways and approaches	Approved by S. F. and tentatively by War Dept.	Towers would be approx. 1,000 ft. high
6	American Toll Bridge Co.	C. Derleth, Jr. Wm. H. Burr D. B. Steinman	High level steel trusses (cantilever)	Carquinez Strait (28 mi. from Golden Gate)	Two 1,100 ft. spans Two 500 ft. anchor spans	Viaduct approach	30 ft. One El. Ry. track 4,750 ft.	6,000,000	Under construction	.....
7	American Toll Bridge Co.	J. G. Little F. H. Reynolds	Steel trusses and viaduct approaches	San Joaquin River, 3 mi. E. of Antioch (58 mi. from Golden Gate)	One 275 ft. lift span; one 290 ft. fixed span 70 ft. above tide level	Sixteen 98 ft. Two 104 ft. steel spans	21 ft. No R. R. tracks 4,639 ft.	1,250,000	Under construction, to be completed in November	North approach on 6% grade, right angle curve on 300 ft. radius

Fixed spans over channels have clearance of 135 ft. above tide level unless otherwise noted in sixth column. *175 ft. above tide level. ‡115 ft. above tide level. **Inclines, 4%.

kept below a depth of 50 ft. and if proper provision were made for taking care of the tidal prism.

(4) A combined bridge and tunnel would be approved if the tunnel is kept below a depth of 50 ft. and if a 3,000-ft. open channel were left on the San Francisco side, suitable provision being made for the tidal prism where bridge and tunnel join.

(5) Not more than one crossing to be approved at present north of San Mateo.

As indications of the trend toward deep waterway development in the more remote sections of San Francisco Bay it is of interest to note that $6,000,000 was recently made available to open a channel 26 ft. deep to the city of Stockton, which is about 95 miles northeast, by water, from the Golden Gate, and that Redwood City, near the southern end of the bay (35 miles from the Golden Gate), recently celebrated sending out a cargo of cement in a steamer whose draft was 24 ft.

The franchise granted three years ago by San Mateo County to F. E. Webb for the construction of a bridge at Little Coyote Knoll recently expired without any actual work having been done, but on request the time was extended 30 days. If the applicant does not satisfy the county authorities and if the franchise is finally declared forfeited, it is understood that an entirely independent group of proponents stands ready to apply for a franchise at this location.

The Bay Cities' bridge project (No. 3 in the table) is backed by the same interests that are building the Carquinez and the Antioch bridges (No. 6 and 7); they assert ability to finance this third bridge if city and War Department sanction is secured. Their plan would include tracks for electric and steam railways if electric and steam railroad companies would enter into an advance agreement as to the use and payment for such tracks. These applications also offer a combined tube and viaduct crossing in case the War Department will not permit the high-level bridge. Thus, in this and in the Marwick application (No. 4) the San Francisco board of supervisors has pending two very similar applications for much the same location. The Davies and Modjeski report on the transbay bridge, dealing particularly with a bridge in this same general location, was abstracted in *Engineering News-Record*, Aug. 18, 1921, p. 268.

The entry of San Francisco into a bridge-and-highway district to be formed to finance the Golden Gate bridge was approved by the San Francisco board of supervisors on April 13, 1925. Districts of this sort are authorized by the Coombs Act, recently passed by the California state legislature, which provides the means of distributing the cost of a bridge over as many contiguous counties as may care to joint the district. As the matter now stands, San Francisco County would bear $\frac{1}{7}$ of the Golden Gate bridge cost, the remainder being borne by other counties of the district. The city attorney has reported that San Francisco County may join this bridge district and underwrite its quota of the bonds without affecting the city's bonding limit because the bonding limit affects the city only and the bridge district is a county matter. The next step is the filing of a petition with the Secretary of State. If there is opposition a referendum election would be held at which voters would vote the county in or out of the proposed district.

Progress on the Carquinez bridge (No. 6) was

announced in a news note in *Engineering News-Record*, June 4, p. 948.

The Antioch bridge (No. 7), which is to be opened for traffic next winter, is regarded as of particular importance to San Francisco because this structure in connection with a highway through the San Ramon Valley and to either the Dumbarton or Little Coyote Knoll bridge will provide a direct highway route from central California into San Francisco without being subject to the delay of ferries or passing through the congested Oakland area.

Recent Sewage Treatment Developments in America

Notes on Screens, Tanks, Separate Sludge Digestion Trickling Filters and Activation, Made During a Visit in June

By Dr. Karl Imhoff
Chief Engineer, Ruhr Verband, Essen, Germany

DURING the writer's visit in America in June he took occasion to inspect a number of sewage treatment plants that were either recently placed in operation or are still under construction. Special features are here described and illustrated.

Screens—Use of the self-cleaning drum screens is spreading rapidly. The Hurd screen at Indianapolis, Ind., and the Dorr screens in many other cities seem to work economically and efficiently. G. W. Fuller's experiments with dry fermentation of screenings in New Rochelle, N. Y., will be valuable.

Settling Tanks—Hopper bottom tanks (Dortmund type) seldom are used in new plants. Construction costs are held to be high. Generally flat-bottom tanks are preferred with revolving Dorr scrapers even in small plants, where the operation of Dortmund tanks undoubtedly would be more economical. Hurd has in Indianapolis, for dealing with the primary sludge, wooden scrapers on an endless chain (Fig. 1) and for activated sludge final hopper bottom tanks with only a little slope (3:1) and revolving scrapers (Fig. 2).

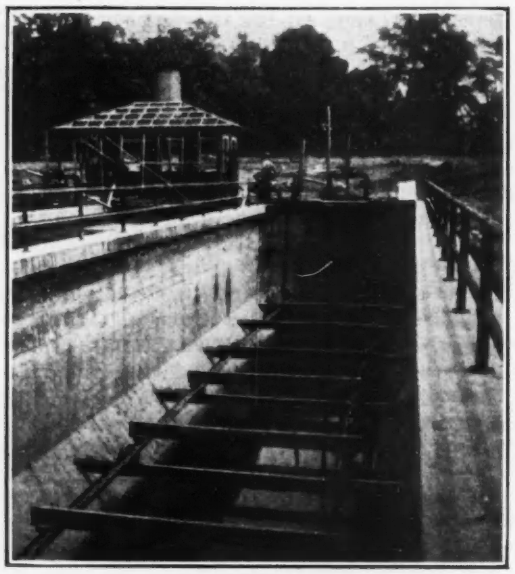


FIG. 1—PRELIMINARY SETTLING BASIN WITH SCRAPER, INDIANAPOLIS

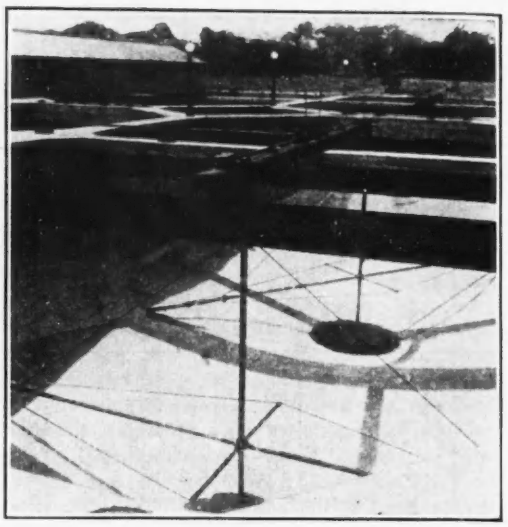


FIG. 2—FINAL SETTLING TANKS FOR ACTIVATED SLUDGE, INDIANAPOLIS

Two-Story Tanks—Since the publication of H. P. Eddy's paper on Imhoff Tanks (*Proceedings*, Am. Soc. C. E., Vol. L, No. 5, May, 1924) more attention has been given to the temperature of the sludge, which in two-story tanks is practically the same as the temperature of the sewage. The sludge room capacity cannot be definitely calculated without knowing the range of sewage temperature during a year. An interesting example (Fig. 3) is the plant in Decatur, Ill. (designed by Pearse, Greeley & Hansen), where the sewage temperature, on account of hot starch factory wastes, is about 95 deg. F. There the digested sludge is of very good quality in spite of the large quantity per capita and the comparatively small sludge room capacity. The gas quantity is apparently much larger per capita than under average temperature conditions.

Foaming in ripening time is reported in plants which were put in operation at the beginning of winter so that large quantities of undigested sludge were accumulated, followed by strong gas development in the spring. Generally now there is little talk about foaming. Engineers say it is only a sign that the sludge level has reached the slots and that at once sludge has to be drawn from the bottom. In Plainfield, N. J., where the sludge chambers (in relation to depth and other construction features and to local conditions) are too small, additional sludge room capacity is being provided by means of secondary sludge digestion tanks. These have been proved useful in similar cases in Germany.

Only little attention is yet given to the utilization of the gases. The reason seems to be that the value of the gases in comparison to the wages in America is lower than in Germany, where the income from selling the gases to city gas works pays the operation expenses of the tanks.

Separate Sludge Digestion Tanks—At a number of new small plants separate sludge digestion tanks have been installed. The Dorr Co. uses a mechanical device for spreading the fresh sludge over the whole surface

and for scraping the old sludge on the bottom (Fig. 4). Since it is known that, aside from inoculation by mixing, temperature is the most essential factor in sludge digestion, and that the temperature of the sludge in separate tanks depends mainly on the temperature of the air, it can be said that the conditions for separate sludge digestion are not favorable in the northern states. But in the southern states probably the average yearly temperature of the sludge will be higher in separate than in two-story tanks. Reports on this from southern cities will be of interest.

Sludge Drying Beds—As a rule sludge drying beds are carefully constructed and operated. In Chicago (Calumet) 8 fillings a year are given, the depth of wet sludge varying from 6 to 18 in., depending on the season (large depths in dry summer months). With these figures the drying area per capita could be smaller than is common in America, more nearly approaching the practice in Germany, where 12 fillings a year are given of 9-in. depth. For glass-covered drying beds (Fig. 5) comparable data are not yet available.

Trickling filters are still predominant, especially in small plants. The main disadvantages are odors and flies. Against flies H. P. Eddy uses chlorine with success. In Madison, Wis., the superintendent, James Macken, sees the reason of absence of flies in a small insect (probably *Achorutes viaticus*). Some plants have sludge nuisance and bad effluent from the final settling basins, where the sludge is removed at long intervals only. In some new plants Dorr scrapers are used for the purpose of keeping the final basins free from sludge.

Activated-Sludge Process—Further advance has been made in the three large activated-sludge plants at Milwaukee, Indianapolis and Chicago (North Side). The Indianapolis plant (Fig. 6) was put in full operation during my visit there in June, and the Milwaukee plant (Fig. 7) was then nearly ready [started up June 26; see *Engineering News-Record*, July 9, p. 75]. The Chicago North Side plant is in an interesting state of construction (Fig. 8). Experiments on the digestion of excess activated sludge are being made on a large scale in two-story tanks at Chicago (Calumet) by Langdon Pearse while at Indianapolis Charles Hurd is experimenting with digestion in separate sludge tanks.

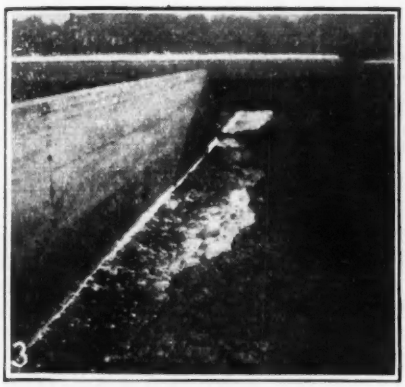


FIG. 3—SURFACE OF SLUDGE CHAMBER IN TWO-STORY TANK AT DECATUR, ILL.

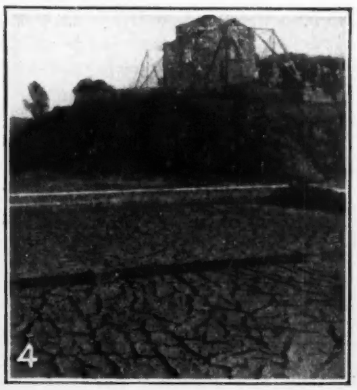


FIG. 4—SEPARATE SLUDGE DIGESTION TANK, HARTFORD, WIS.
Revolving Dorr scraper on surface and bottom of tank. Digestion tank on hill and sludge drying beds in foreground.

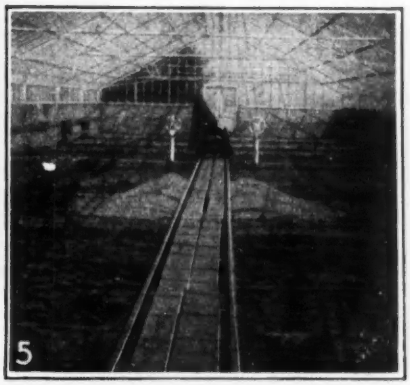


FIG. 5 — GLASS COVERED SLUDGE-DRYING BED, PARK PLANT, NORTH SHORE, CHICAGO

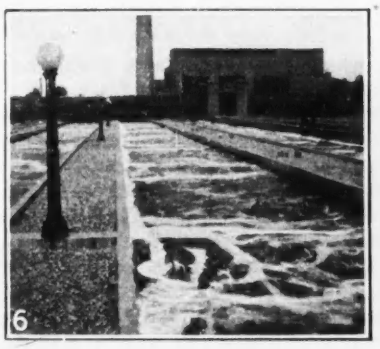


FIG. 6 — INDIANAPOLIS AERATION TANKS IN OPERATION

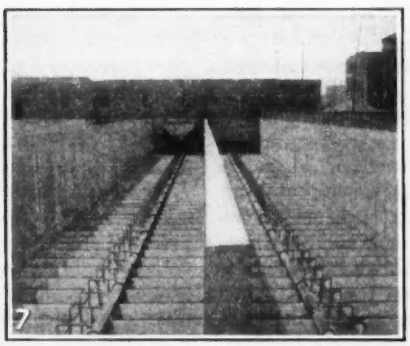


FIG. 7—EMPTY AERATION TANKS AT MILWAUKEE

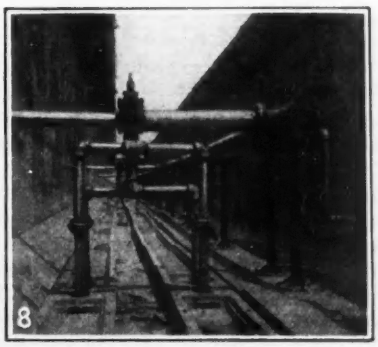


FIG. 8—BOTTOM OF AERATION TANK AT CHICAGO (NORTH SIDE)

Life of Structures for Bond Purposes Defined

Among the laws passed at the recent session of the New York State Legislature was an amendment to Sec. 51 of Chap. 58 of the Laws of 1909 establishing a legal length of life for various structures for use when issuing bonds for financing their construction. The revision increased the probable life of sidewalks of brick, stone, concrete, crushed stone, rock dust, cinders or asphalt to 25 years and added clauses placing the life of dams, docks and sea walls at 25 years and of park improvements including forestry work, fire protection, planting, grading and park equipment at 25 years.

California Road Bridge Concrete All Tested in Field

Both 10-Day and 28-Day Tests Now Standard Practice Followed by the State Highway Department

By Harlan D. Miller

Bridge Engineer, California State Highway Commission, Sacramento, Calif.

During the last year and a half careful tests have been made of the strength of the concrete used in about 50 state highway bridges built in various parts of California. These tests are proving of considerable interest because they show what strength of concrete is obtained under actual working conditions using various brands of cement.

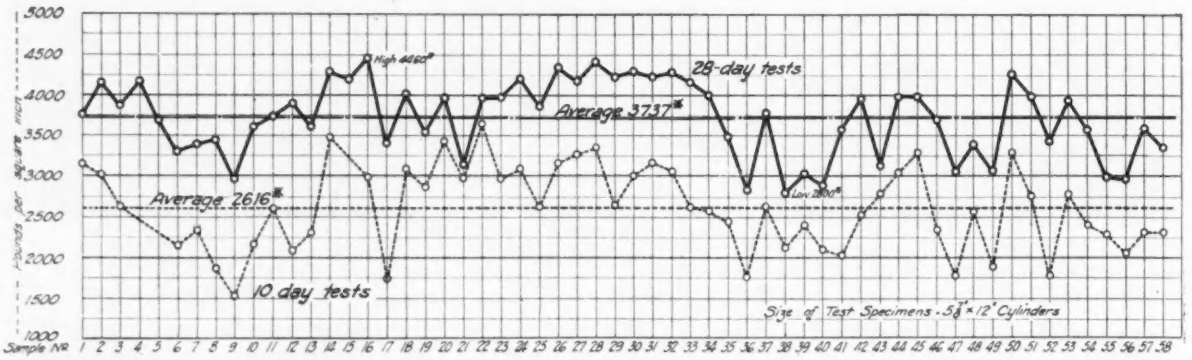
In all about 800 samples of concrete have been taken in the construction of the 50 bridges. About one-half of these samples have been tested at the age of 10 days and about one-half at the age of 28 days. As soon as the 10-day test is made the resident engineer in the field is immediately notified. If the result is not satisfactory he knows that something is wrong and an effort is immediately made to find out the cause of the poor concrete and to rectify the mistake so that there will not be a repetition of the poor result. Therein lies the principal value of the 10-day tests. If poor concrete is being obtained we know it and although the poor concrete cannot be removed, nevertheless, we can try to find out the cause of it and aim to improve that which is to follow.

The samples of concrete are taken as the concrete is poured from the mixer on the work. Careful precautions are taken to see that the sample is typical of all of the concrete of the run and that it represents average conditions in every respect. The sample of concrete is poured into pasteboard cartons which cast it in the shape of cylinders 6 in. in diameter and 12 in. long. These cylinders are kept wet on the job until of the desired age when they are shipped to the State Testing Laboratory for breaking.

The tests so far made cover concrete made from seven different brands of cement and many different kinds of aggregate, and made under the supervision of about twenty different resident bridge engineers, so that the tests can fairly be said to represent actual field concrete as it is now being produced in the bridges in the various parts of California.

The highest sample of 28-day concrete of the 1:2:4 mix tested from the 50 different bridges broke at 5,190 lb. per sq.in., the lowest at 1,840 lb. per sq.in., with an average for about 350 samples of 3,400 lb. per sq.in. The average strength of the highest 10 per cent of the samples taken was 4,450 lb. per sq.in. and the average of the lowest 10 per cent of all samples taken was 2,220 lb. per sq.in. The accompanying chart shows the results from seven different bridges in one county. The average strength of the 28-day concrete for these bridges is 3,737 lb. per sq.in., which, according to the Joint Committee would permit an allowable unit stress in design of 1,500 lb. per sq.in. According to the chart the lowest test made of the 28-day concrete showed an ultimate strength of 2,800 lb. per sq.in., for which the allowable unit stress would be 1,120 lb. per sq.in. These results, which are typical of our field tests, seem to indicate that a designing stress of 650 lb. per sq.in. is very conservative when the concrete is carefully proportioned and inspected.

The average slump of all of the concrete used in the 50 bridges built during the last year and a half was about 2½ in. This included concrete for columns, beams, girders, slabs, arches, railings, posts, piles, etc.



COMPRESSION STRENGTH AT 10- AND 28-DAYS OF FIELD CONCRETE ON CALIFORNIA STATE HIGHWAY BRIDGES

At the present time the Bridge Department is making a very earnest effort to secure uniformity of results and not high strength in its concrete. With this in view the resident bridge engineers are drilled in the theory of the proportioning of aggregates, careful measurement of water content, bulking of sand, etc. All aggregates are very carefully proportioned according to the Abrams theory to produce the greatest workability with the least amount of water.

No resident bridge engineer is retained upon a job where honeycombing or voids are found in the concrete upon stripping of the forms.

Practical Value of Tests—Several valuable results have been found from the practice of testing field concrete. It gives confidence in the concrete produced since it is actual proof that the concrete has the strength desired. It shows the value of the various kinds of aggregate and the various brands of cement used under field conditions. It provides a great incentive to the various resident bridge engineers to watch carefully the proportioning of the aggregate and the amount of water used in the concrete, and causes the various resident engineers to vie with one another to see who can produce the best concrete. Each resident engineer is thus kept alert to see that the concrete produced under his supervision is fully up to the standard that is produced by the others.

Earthquake-Resistant Construction: Suggestions from Tokyo

Principal Conclusions Drawn from Experiences in Japanese Earthquake—Light Floors, Strong Walls and Thorough Interconnection Are Vital — Some Remarks on Foundations and on Materials

By R. F. Moss
Vice-President, Truscon Steel Co. of Japan, Tokyo

AN EARTHQUAKE consists of vibrations, both horizontal and vertical, in the earth's crust. These horizontal and vertical vibrations may occur simultaneously, and the horizontal vibrations may occur in several directions during the same earthquake. The amplitude, that is, the maximum horizontal movement in any direction, may in the case of destructive earthquakes be as much as 18 in. It varies considerably for different localities during the same earthquake, and varies in the same locality according to the hardness of the earth's crust at any point—the amplitude, and therefore the severity of the earthquake, being generally greater in soft than in hard soil. Seismologists and engineers rate the severity of earthquakes by acceleration, this meaning of course the rate of increase in the velocity of the earth's surface at the point under observation. In the downtown part of Yokohama the maximum acceleration during the great earthquake was about 11 ft. per sec., the time between successive shock waves about 1½ sec., and the maximum amplitude about 15 in. This means roughly that a given spot on the earth's surface, quiescent to begin with, attained a velocity of three or four miles per hour, slowed down to quiescence again, moving about 15 in. in the process, then reversed its direction and repeated the process back to the starting point, all in 1½ sec.

The vertical movement and acceleration are usually from one-sixth to one-third as much as the horizontal, and seldom, if ever, greater than about one-tenth that due to gravity. The horizontal acceleration may, however, be as great as four-tenths of the acceleration caused by gravity. The really destructive portion of an earthquake seldom lasts longer than about ten seconds.

Inasmuch as the vertical part of the earthquake exerts a force of not more than one-tenth the force of gravity, it is clear that this part of the earthquake cannot harm any properly designed building. It is also clear that there can be no appreciable difference in the lifting of different parts of the same building by the vertical vibrations, because the earthquake wave length varies from 30 to 300 mi. We may therefore eliminate the vertical vibrations from further consideration.

Effect of Horizontal Vibration—The horizontal movement must necessarily be transmitted to the foundation of the building, which will move in the same direction and with approximately the same acceleration as the earth surrounding it. The inertia of the upper portion of the building tends to make it stay in its original position, and the walls and columns are suddenly called upon for the strength necessary to overcome this inertia and move the building with the foundation. Successive shock waves follow, each moving the foundation horizontally, forward and backward, the walls and columns having to perform the work of moving the part of the building that is above them with each successive horizontal movement of the earth. As the walls and columns of each floor have only to do the work of moving that part of the building which is above them, it follows that the walls and columns of the first floor will be called upon to resist forces greater than those which must be resisted by the walls and columns of the second floor, the forces decreasing from foundation to roof. The greater the weight of the floors and roof, the greater will be the work to be done by the walls and columns, and therefore the greater the strength required in these parts of the structure.

Observed Damage—In a number of buildings in the Marunouchi district of Tokyo the greatest damage was usually found between the second and third floors, and the question naturally arises as to why the greatest damage was not between the first and second floors if that is where the greatest forces are to be resisted. The answer is that the walls of the first floor are usually made of well laid stone and are strong enough to do the work that they are called upon to do, this is, to move the part of the building above them, but the walls of the second and higher floors, made of brick or terra cotta, which are much weaker materials, were in some cases not strong enough to move the part of the building above them.

It follows that in designing buildings to resist earthquakes, the floors should be made just as light as possible. Walls and columns *must* be made strong enough to do the work that they will some day be called upon to do, namely, to move the weight of the whole of the construction that is above them, in any horizontal direction and at an acceleration that should be determined by experts for each locality.

Wall Strength Primary—If we attempt to ascertain how much of the work of moving the weight of the portion of the building that is above any level is done by the columns and how much is done by the walls, we immediately see that it must nearly all be done by the walls or the walls will fail, especially in the case of steel-frame buildings, as the masonry walls are in intimate contact with the steel columns on all sides and are always, necessarily, stiffer than the columns. Observation supports this reasoning completely. The Yuraku and Yusen Buildings have columns as strong as any I have ever seen, having been designed especially to resist earthquakes, but the walls of these buildings were damaged in the same way and to approximately the same extent as were the walls of the Marunouchi and Kaijo Buildings where the steel columns were very much lighter. The extent of the damage depended inversely on the strength of the walls.

The principle *light floors and strong walls* is by far the most important consideration in the design of buildings to resist earthquakes. The whole question of proper design rests on this principle.

Interconnection—From the reasoning given above it is also clear that the attachment between the floors and the walls must be strong enough to enable the latter

to move the former when the earthquake comes. Many buildings failed from the lack of sufficiently strong connections to enable the walls to transmit the earthquake motion to the floor and roof. Brick walls with floors supported on steel or wood beams and with roofs supported on steel or wood trusses proved to be a very dangerous type of construction, because it is hard to make a strong connection between such different materials.

Large open floor spaces in multiple-story buildings should be avoided whenever possible, and, when they cannot, special precautions should be observed in the design of the walls and columns. For the same reason it is dangerous to build multiple-story buildings with too much window area in the outside walls. Wall strength is absolutely necessary and glass will not provide it.

Foundations—With regard to foundations, the available evidence indicates that buildings on strong pile foundations receive more shock than buildings on the so-called mat or floating foundations, but that greater vertical settlement occurs in buildings on the latter type. In the case of buildings on floating foundations there is probably a considerable amount of slipping between the foundation and the earth directly beneath it, which would reduce the amount of horizontal motion in the building. The crushing of sidewalks around buildings, noticed in many places, is evidence of this slipping. I understand that this slipping between the earth and the foundation has long been recognized by architects in Japan, and that it is an old practice to put a layer of sand below the foundation to facilitate slipping and thus reduce shock. Inventors have attempted to utilize this principle by putting buildings on ball or roller bearings, but so far no one has evolved a practical design.

All parts of the foundation should be so well connected together that all will move as a unit. We find that generally buildings on continuous reinforced-concrete foundation stood the effects of the earthquake better than buildings erected on isolated pier foundations.

Materials and Types—Taking up next the behavior of different kinds of building materials, our observations show that well laid stone of good quality suffered very little. The behavior of brick walls seemed to depend entirely on the workmanship and quality of the brick and mortar. In Yokohama brick buildings generally collapsed. In Tokyo, where the shock was less severe, brick buildings generally stood, if of first-class workmanship. Terra cotta and hollow tile suffered severely. This is to be expected, as these materials have very little structural strength. Structural steel buildings generally stood the earthquake shock, but suffered severe damage unless built with strong masonry walls and partitions. Reinforced-concrete buildings seemed to stand the combined earthquake and fire test better than any other type, with the possible exception of steel-frame buildings with reinforced-concrete walls, floors, and column fire-proofing. Of a total of 593 reinforced-concrete buildings investigated in the city of Tokyo, 7 collapsed, 13 were damaged so that they had to be pulled down, 42 suffered severe but reparable damage, 69 suffered small damage, and 462 were not damaged at all. In Yokohama, nearly all of the buildings that remained after the earthquake and fire were reinforced concrete.

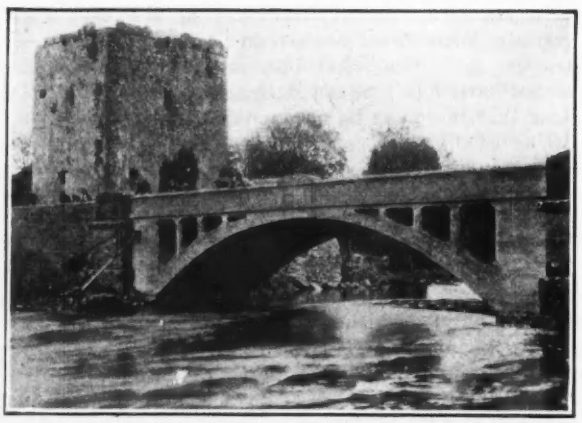
Mill Buildings—For one-story factory buildings where large open spaces are required for manufacturing processes, the obvious solution would seem to be steel frame construction with roofs of steel sheets either galvanized or made of a non-corrosive steel alloy and painted, and with walls of the same material or preferably of metal lath and waterproofed cement stucco. The building should be protected by an *earthquake proof* sprinkler system. Cost considerations usually rule out the possibility of effective cross-connection of foundations in such buildings, but all foundations should be connected along each wall line and should be designed so safely that they can never be overloaded. Such buildings may be damaged by a severe earthquake, but if properly designed the damage will be small.

Height—With regard to the question of the maximum height of buildings to be allowed in future, there has been some talk about limiting height to two or three stories. I regard this as unreasonable because buildings of all heights up to eight stories successfully withstood the earthquake forces. Many buildings only one and two stories high failed. Height, within the reasonable limit of one hundred feet already established by the Building Code was not the determining factor.

Economy—Fortunately, the lessons of the earthquake do not rule out the economically designed structure but are rather to the contrary. They tell us, for instance, to avoid all unnecessary ornamentation because it is dangerous when it breaks off and falls down, and also because it loads the structure with additional weight which the walls and columns must move. They tell us to avoid all attempts at massive effects, but to make our structure light and strong, which will also make for economy.

Type of Bridge Being Erected in Ireland

According to information sent this journal by J. K. Prendergast, resident engineer in Maentwrog, North Wales, the photograph herewith reproduced represents the type of highway bridge now being erected in the west of Ireland to replace old stone-arch structures



CONCRETE ARCH IN COUNTY GALWAY, IRELAND

damaged or totally destroyed during the civil trouble in Ireland a little over a year ago. The new bridges are of reinforced concrete, simple arch type, in which round bar reinforcements are used. The deck is also of reinforced concrete, covered with a surface layer of macadam. The bridge shown is in County Galway.

Corrosion of Metals: Test Methods and Results

Tests of Corroded Metal Discussed, Results of Large Series of Accelerated Weathering Tests of Conductor Wires and Strand—Abstracts of A.S.T.M. Papers

Measuring the Physical Effect of Corrosion

By E. Blough
Technical Director, Aluminum Co. of America, Pittsburgh

ONE common criticism applies to all current methods of determining the effect of corrosion (inspection, measuring loss of weight, analyzing the products of corrosion, measuring the depth of corrosion), and that is they do not disclose the effect corrosion has produced upon the residual metal which is apparently unattacked. Neither do they disclose a condition wherein there may be no apparent corrosion but where there may be an interior disintegration.

One method of measurement which avoids the above mentioned criticism is to subject the specimens after corro-

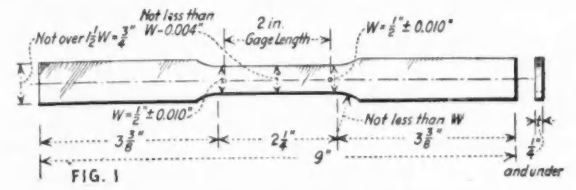


FIG. 1

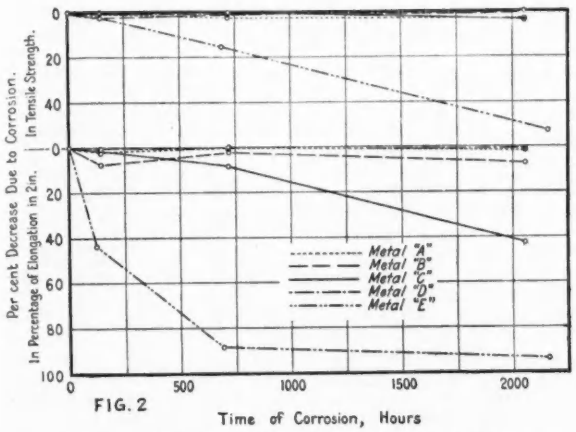


FIG. 2

FIGS. 1 AND 2—CORROSION TEST SPECIMEN AND CURVES OF RESULTS

sion to physical test. In order to demonstrate the use of this method, the author conducted a series of salt spray tests on five commercial non-ferrous metals, *A*, *B*, *C*, *D* and *E*. The materials were all in sheet form and the samples used for corrosion tests were standard sheet test specimens as shown in Fig. 1. The materials were tested before being subjected to the salt-spray test, and blank samples were also held for test after the completion of the experiment in order to be sure that no aging effect had taken place in any of the materials, due to lapse of time.

Three series of samples were used in the test; the first for a period of 120 to 144 hours; the second 689 to 720 hours, and the third series was removed at the end of 2,056 to 2,160 hours. The samples, on removal from the salt-spray tank, were immediately washed and dried in order to avoid any continuation of corrosion due to exposure to the air, and then subjected to tensile strength and elongation measurements.

After the data were accumulated from the complete series, the results were calculated on the basis of percentage of loss using the uncorroded material as the unit basis. The results obtained from this tabulation are shown in the table. These results are also shown in the curves of Fig. 2, each value representing the average of tests on three specimens.

EFFECT OF CORROSION ON PHYSICAL PROPERTIES

Sample Mark	Change in Tensile Strength, Per Cent	Change in Elongation, 2 in.	Change in Tensile Strength, Per Cent	Change in Elongation, Per Cent	Change in Tensile Strength, Per Cent	Change in Elongation, Per Cent
	144 Hours		720 Hours		2056 Hours	
A	—0 79	—2 09	—2 47	+1 12	—3 33	— 1 93
B	—2 37	—7 61	—0 96	—2 17	+0 14	— 7 61
C	+0 14	—1 78	+0 21	—8 28	—3 79	— 42 3
D	—0 62	—0 44	—0 80	—0 44	+3 68	— 1 11
	120 Hours		689 5 Hours		2160 Hours	
E	—1 32	—43 6	—15 5	—88 7	—52 9	—93 8

It will be seen from the study of these results that metal *E* shows a gradual decrease in tensile strength with a very rapid loss in elongation. It may also be noted that metals *A* and *D* under this test show relatively little attack, while metal *C* shows a loss of elongation although its tensile strength has been but little affected.

* * *

Accelerated Corrosion Tests on Wire and Strand

By Frank F. Fowle
Consulting Engineer, Chicago

THE original motive in conducting the tests described in this paper was to determine what effect, from the viewpoint of resistance to atmospheric corrosion, would result from removing the center wire of a 7-wire galvanized steel strand and substituting a galvanized or tinned copper wire. Considerable prior work had been done by the author on such a type of copper-steel strand to determine its electrical and mechanical properties as an electric power conductor and the results were thought sufficiently encouraging to justify an investigation of the resistance to corrosion. In planning this investigation it was finally decided that the results would be more useful if all the usual types of bare (uninsulated) overhead electrical conductors were included and therefore specimens of several commercial grades of galvanized iron and steel wire and strand, bare copper wire and strand, aluminum wire, steel-reinforced aluminum strand, and copper-clad steel wire and strand, were added to the list.

After reviewing the earlier methods for testing the durable properties of a zinc coating, in a comparatively brief operation, it was felt that none of them simulated the corrosive influences usually present in the atmosphere, as found in the great majority of localities about the country.

The method finally developed for this test consisted in placing specimens of wire and strand, about 14 ft. in length, in a closed box where they were exposed to successive cycles of corroding conditions in the following order: Warm dry air, 3 hr.; warm moist air, 1.5 hr.; air charged with bituminous coal smoke, 3 hr.; heavy fine water spray, 0.5 hr.; total cycle, 8 hr. This cycle was repeated continuously day and night, except Sundays and holidays, with only an occasional interruption. The samples were taken out and examined at intervals, as later explained.

A general view of the apparatus is shown in Fig. 1. The box was 16 ft. long, 5 ft. wide and 4 ft. high, constructed of wood and lined with tarred roofing paper. Access to the interior was provided by making the cover of the box removable, by attaching it to counterweighted overhead ropes.

Gentle circulation of air and gas was maintained by a small exhaust fan at the outlet, connected as an ejector in order to avoid corroding the fan itself. The transverse baffles indicated, caused the circulation to pass repeatedly across the test specimens. Dry and humid air were conditioned in the apparatus shown at the left-hand end of the

TABLE I—SUMMARY OF RESULTS OF CORROSION TESTS ON ELECTRICAL CONDUCTORS

Identification Mark	Wire or Strand	Bare or Coated	Description	Conditions Noted at Ends of Various Cycles: 99	207	302	359	416	461	573	686	793
1-A	Wire	Bare	Aluminum	S.C.	.....	S.C.	¼ C.	.....	.....	.....	C.	C.
1-B	Strand	"	Steel-reinforced aluminum	.....	.....	S.C.	S.C.	.....	.....	.....	C.	C.
2-A	Wire	Bare	Copper	S.C.	.....	S.C.	C.	.....	C.	.....	C.	C.
2-B	Strand	"	"	S.C.	S.C.	.....	.....	.....	.....	.....	C.	C.
3-A	Wire	Bare	Copper-clad steel	S.C.	.....	C.	C.	C.	.....	.....	C.	C.
3-B	Strand	"	" " "	S.C.	S.C.	S.C.	.....	½ C.	C.	.....	C.	C.
4-A	Strand	Double galvanized	Extra high strength steel *a*	.....	.....	.....	S.C.	1 F.	.....	.....	4 F.	½ F.
4-B	"	" "	Siemens-Martin steel *a*	.....	.....	.....	S.C.	.....	.....	.....	.....	½ F.
4-C	"	" "	High-strength steel *a*	.....	.....	.....	S.C.	.....	.....	.....	3 F.	½ F.
4-D	"	" "	" " " *b*	.....	.....	.....	S.C.	.....	.....	.....	12 F.	½ F.
5-A	Wire	Bare	Ingot Iron	C.	.....	C.	D.P.	.....	.....	*c*	.....	.....
5-B	"	Double-galvanized	" "	.....	C.	½ C.	½ F.	¾ F.	.....	½ F.	.....	$\frac{9}{10}$ F.
6-A	Wire	Double galvanized	Best Best Iron	.....	.....	.....	1 F.	.....	2 F.	1 F.	All F.	All F.
6-B	"	" "	Steel	.....	.....	.....	.....	⅝ F.	.....	⅝ F.	$\frac{9}{10}$ F.	All F.
6-C	"	" "	Extra Best Best Iron	.....	S.C.	.....	½ F.	½ F.	½ F.	½ F.	$\frac{9}{10}$ F.	All F.
6-D	"	" "	Swedish Iron	.....	.....	.....	.....	.....	.....	¼ F.	¾ F.	⅝ F.
6-E	Strand	Double-galvanized	Siemens-Martin steel	.....	.....	S.C.	.....	.....	.....	3 F.	½ F.	½ F.
6-F	"	" "	Steel	.....	.....	S.C.	S.C.	C.	.....	5 F.	.....	All F.
6-G	"	" "	High-strength steel	.....	.....	.....	S.C.	.....	.....	.....	3 F.	¼ F.
6-H	"	" "	Extra high strength steel	.....	.....	S.C.	.....	.....	.....	.....	3 F.	.....
6-I	Wire	Bare	Swedish iron	C.	C.	C.	D.P.	.....	.....	.....	.....	.....

a One tinned hard-drawn copper wire in the center of the strand.
b One galvanized copper wire in the center of the strand.
c Denotes the advance of corrosion to a point where the specimen is reduced to one-half of its original diameter.
S.C. denotes slightly corroded.
C. denotes badly corroded.
F. denotes local point of failure of protective coating.
D.P. denotes deeply pitted.
Integers denote number of separate local points of failure; thus 3 F. denotes three points of failure.
Fractions denote proportion of total length of specimen which has failed; thus ¾ F. denotes failure over three-fourths of the total length.

box. This consisted of an open-bottom sheet-metal cylinder, attached at the top to the intake pipe leading to the corrosion box, with the bottom placed immediately above a gas-heated iron plate. Warm dry air was produced by drawing normal air from the room into this cylinder, across the hot plate. Moisture-laden air was produced by allowing water to drip in sufficient quantity on the hot plate. Wet and dry bulb thermometers were placed inside the corrosion box to observe the temperature and humidity.

Smoke Generator—Smoke-laden air was obtained by burning bituminous coal in the receptacle or "stove" shown at the right of the air heater in the illustration. It consisted essentially of a cylinder of pipe, opening into a branch of the intake pipe to the corrosion box, and provided with a grate and a Bunsen burner. The rate of combustion was controlled by regulating the gas flame.

The condition of outdoor rain was simulated by a fine water spray from nozzles arranged around the upper sides of the box, so that the specimens received a thorough drenching from above.

The test specimens, initially about 14 ft. in length, were supported on small brown porcelain insulators with top grooves. These insulators were mounted on wooden pins, in turn supported by wooden cross-pieces spanning from side to side of the box, about midway between the top and the bottom. Every effort was made to keep the interior of the box and the supports in a chemically inert condition and hence avoid any effects except those specifically sought for.

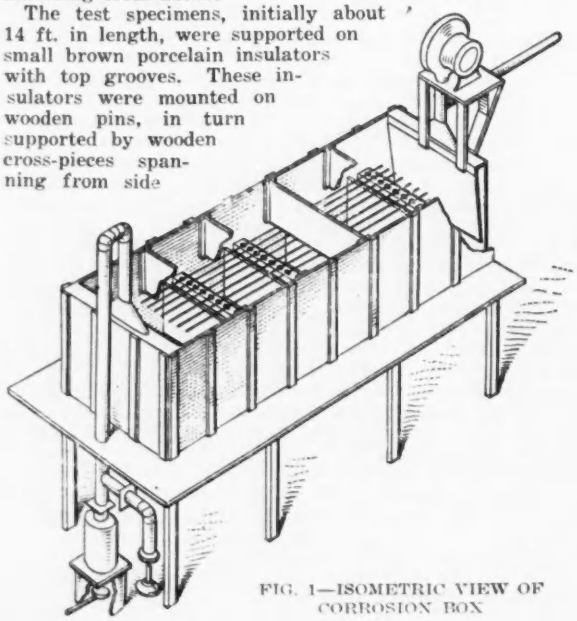


FIG. 1—ISOMETRIC VIEW OF CORROSION BOX

Out of 21 samples used in this investigation, 14 contained one or more wires of iron or steel which had protective coatings, in most instances of zinc. These coatings were tested for initial condition in two ways, one by stripping and ascertaining the weight per unit area, and the other by the Preece test. It is notable that some of the specimens did not come up to the requirement of four one-minute dips, but showed up pretty well on the corrosion test, whereas some specimens which withstood four or more dips did not stand up as long in the corrosion box. Another interesting point is the absence of any linear relation between the weight of the coating and the number of dips before failure in the Preece test. For example, 6-H with a weight of 1.18 oz. per sq. ft. withstood only three dips without failure, whereas, 6-A with 1.02 oz. per sq. ft. withstood seven dips.

TABLE II—COMPARISON OF TENSION TESTS ON CERTAIN SPECIMENS BEFORE AND AFTER SUBJECTION TO CORROSION TESTS

Identification Mark	Material	Elapsed Cycles	Breaking Load, Lb.: Before Corrosion	Breaking Load, Lb.: After Corrosion	Elongation in 10 in., Per Cent: Before Corrosion	Elongation in 10 in., Per Cent: After Corrosion
1-A	Aluminum wire	793	577	549	3.8	1.8
2-A	Copper wire	793	1,337	1,333	1.0	1.4
3-A	Copper-clad steel wire	793	2,030	2,000	1.5	1.6
5-A	Bare ingot iron wire	573	732	370	24.9	.....
5-B	Galvanized ingot iron wire	793	935	767	15.0	8.7
6-A	Galvanized best best iron wire	793	1,072	956	17.3	13.8
6-B	Galvanized steel wire	793	1,304	1,182	15.2	12.1
6-C	Galvanized extra best best iron wire	793	1,061	821	16.3	8.6
6-D	Galvanized Swedish iron wire	793	1,075	927	13.1	9.5
6-I	Bare Swedish iron wire	793	880	464	23.4	.....

The corrosion box was placed in regular operation on July 23, 1923, and continued without interruption except for Sundays, holidays and periodic examinations of the specimens, until June 30, 1924, at the termination of 793 cycles. In actual equivalent time this was equal to 264⅛ days of 24 hours each, or 0.725 year of continuous exposure in the box. The test was stopped at this point because one or more definite failures had developed in the coatings of all of the galvanized wires, although varying widely in severity and superficial area.

At roughly 100-cycle intervals, the test was stopped, the box opened and the specimens removed for careful examina-

tion to detect evidences of corrosion. In most instances, short pieces (about 3 in. long) were removed from the ends of the 14-ft. specimens and coated with a transparent (celluloid) solution. These short specimens were kept as permanent exhibits to show the progressive behavior of each main specimen throughout the test. Whenever the specimens were replaced in the box after such examination, care was taken to reverse them, end for end, so that any differences in corrosive effects throughout the length of the box would tend to be equalized.

Chemical analysis of the coal-smoke atmosphere in the box on two different occasions showed that the carbon dioxide ranged from 5.1 to 8.6 per cent, tending toward the lower figure at the far end, or exit point of the gases. Sulphur determinations made at the center of the box gave 86 parts, by volume, of sulphuric acid per million parts, by volume, of total gas. The temperatures in the box ranged from approximately 14 to 42 deg. C. (57 to 108 deg. F.) under different conditions, tending toward the upper figure at the end of the humid air period and toward the lower at the end of the spray period.

The results have been condensed into very brief form in Table I. Every specimen in the box showed at least some corrosion by the end of the test and practically all of the coated specimens developed substantial or complete failures of their coatings.

The specimens of aluminum, copper and copper-clad steel all behaved in much the same manner, remaining bright for a time after the test started, then discoloring, first in patches and then all over; at this point the surfaces exhibited definite evidence of incipient corrosion; this then developed gradually into an exceedingly thin scale, which

TABLE III—LOSS IN WEIGHT DURING TEST

Identification Mark	Elapsed Cycles	Per Cent of Original Weight	Loss in Weight, Per Cent
5-A	461	49.4	50.6
	573	49.7	50.3
6-I	461	82.4	17.6
	573	86.0	14.0

finally became easily loosened and detachable, revealing another layer of oxide beneath. The actual loss of metal was not measured, but was unquestionably very slight. Although the surfaces were strongly attacked, there were no distinct failures.

The specimens of galvanized iron and steel all behaved in a characteristic manner, remaining bright for a time, then discoloring in grayish patches, becoming general; the color next turned dark gray and then became blackish, but there was more tendency to develop pits than to scale; the last stage was the appearance of reddish spots of rust, which ultimately spread and enveloped the specimen as a whole. When a rust spot once develops, the succeeding action is first a slight swelling or increase of volume, which often causes splitting of the coating, and thus the area of failure tends to spread out. The characteristic blackening of the coatings in the last stages before incipient failure, is thought to be indicative that the outer portion of the coating, consisting for the most part of pure zinc, has disappeared, leaving only the layer of zinc-iron alloy as the remaining protection.

The two samples of uncoated iron wire, ingot iron 5-A, and Swedish iron 6-I, both commenced to corrode from the start of the test and lost metal rather rapidly. The ingot iron lost metal at considerably faster rate than the Swedish iron.

Tension Tests After Corrosion—In Table II there is a summary of tension tests made on certain specimens after the completion of the corrosion tests, with comparative figures showing the strength of the same specimens before corrosion. It is interesting to compare the loss of weight, by corrosion, as given in Table III for the bare iron wires, with their respective losses of strength, given in Table II. In the case of ingot iron, the comparison appears rational, but in the case of Swedish iron it does not, perhaps because of pitting.

Comparison of Failures—It appears reasonable to denote failure of the zinc coating as that point in the test at which the existence of iron rust becomes rather prevalent over the whole length of a specimen, rather than a few isolated small occurrences of it; especially if the isolated occurrences are of no appreciable depth or extent. Taking the

TABLE IV—COMPARISON OF FAILURES ON GALVANIZED SPECIMENS

Identification Mark	Wire or Strand	Description	Number of Cycles to Failure	Number of Dips to Final Failure	Weight of Coating, Oz. per Sq. Ft.
4-A	Strand	Extra high strength steel (copper center)	793	6	1.09
4-B	Strand	Siemens-Martin steel (copper center)	793	8	1.22
4-C	Strand	High strength steel (copper center)	793	5	0.86
4-D	Strand	High strength steel (copper center)	793	5	0.94
5-B	Wire	Ingot iron	359	5	1.05
6-A	Wire	Best best iron	573	8	1.02
6-B	Wire	Steel	573	6	1.15
6-C	Wire	Extra best best iron	359	7	0.82
6-D	Wire	Swedish iron	686	7	1.28
6-E	Strand	Siemens-Martin steel	686	6	0.97
6-F	Strand	Steel	793	5	1.15
6-G	Strand	High-strength steel	793	5	1.02
6-H	Strand	Extra high strength steel	793+	5	1.18

condition of failure over at least one-third of the entire length as denoting the point at which a specimen as a whole has failed, from Table I, and contrasting the number of cycles up to this point with the Preece test data, produces the interesting exhibit given in Table IV. These results indicate that neither the number of dips (to failure) in the Preece test, nor the weight of the coating, are sufficient of themselves to predict the durability of any particular coated specimen in these tests.

Normal Atmospheric Correction Test—Specimens taken from the same original wires and strands as those in the corrosion box were suspended on an outdoor rack on the roof of the Laboratory and examined periodically.

Conclusions—The conclusions drawn as to the relative performance of the various specimens in resisting the attack of simulated corrosive conditions of unfavorable outdoor atmospheres, under accelerated application, are as follows:

1. The copper and aluminum wires and strands did not show serious corrosion up to 302 cycles and there were no marked failures at any time either in the copper-clad steel or in the reinforcing wire of the aluminum cable.

2. There is little, if any, difference between the corrosion in solid wire and stranded wire of the same grade of material.

3. The copper-center steel strand resists corrosion fully as well as the standard material of the same grade.

4. The higher the carbon content of the galvanized iron and steel specimens, the greater is the apparent resistance to corrosion.

Some Faults in Foundation Planning

IN a recent address to the American Railway Bridge and Building Association, J. L. Harrington, Kansas City, charged that foundation design is frequently neglected, as compared to superstructure design.

The most glaring inconsistency in foundation design is the excessive reliance too commonly placed upon piles. The superstructure and the piers are carefully designed to carry present loads, often to provide for a future increase in loading, with a large factor of safety. Then, too frequently, the supporting piles are trusted almost to their full carrying capacity, though, of course, a structure is no better than its foundations. Grave failures have resulted from this practice; witness the Portland elevator; but it persists largely out of the desire to save the cost of larger and more adequate foundations.

Sometimes the economic policy of the management rather than sound engineering judgment governs design. Not many years ago the engineer of maintenance-of-way of one of our Class A roads exhibited photographs of more than 20 abutments that had moved or tipped forward. Some were braced apart by timber struts suspended from the span and sometimes bent to the shape of a letter "S" by the continued movement of the abutments. I asked the ratio of base to height. "About 28 per cent," he said. I asked what was the ratio used in his current designs. He said "Just the same, 28 per cent." The management believed that the saving in first cost of the lighter abutments warranted the risk of failure of a portion of them.

Quantity Production of Ground Water from Wells in Sand

Gravel Wall Against Screens Instead of Natural Sand Wall Reduces Velocity of Flow and Increases Specific Capacity

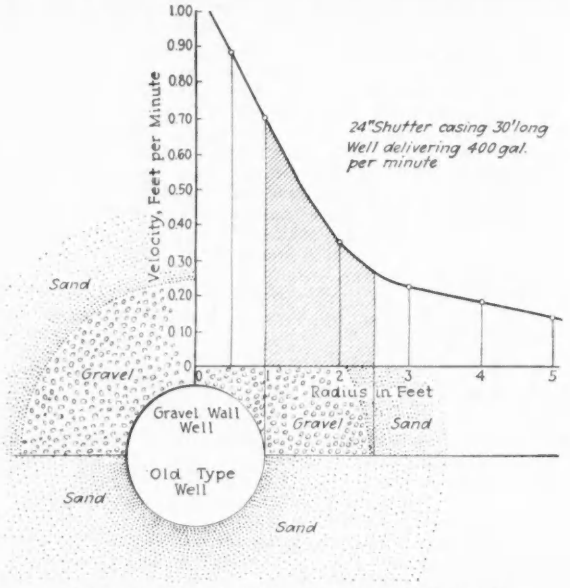
By J. G. Gordon
Chief Engineer, Layne & Bowler Co., Memphis, Tenn.

HOW to sink deep wells in loose water-bearing sand overlaid by impervious material in a way to obtain large quantities of water at low cost is the subject of this article. Such wells in diameters of from 10 to 40 in. usually have an inner and an outer steel tube, the former being provided with a slotted metal well screen surrounded with a gravel wall to hold back the sand and yet let water enter with small loss of head.

The efficiency of a well is expressed in terms of its specific capacity, or the production in gallons per minute per foot of drawdown from the true static level. Any method of reducing the resistance to water flow through the sand and the screen will result in either increased flow for the same loss of head, or decreased loss of head for the same flow. Flow of water into a well tends to carry sand with it, and this sand has a tendency to cut the screen and eventually cause trouble. The amount of sand carried is a function of the velocity of flow into the well, taking the velocity at the surface of the sand wall. In the ordinary well the sand wall is against the screen which makes the velocity of water entering the well the same as when leaving the sand wall.

For a given well output, lowering the resistance to water flow into the well will raise the pumping level and increase the specific capacity of a well. With a given well output it is desired to reduce the velocity of water as it leaves the sand wall to lessen the amount of sand carried and thereby protect the screen. These two conditions are both met by the gravel wall well.

Sinking the Well—The upper and usually harder formation through which a well is drilled is penetrated by a rotary drill to the top of the water-bearing formation. The drill is then withdrawn and the pit casing inserted. The proper length of large opening metal screen section with a cone bottom is placed within the pit casing and gravel filled in the space between the screen and pit casing. The cone-shaped bottom of the screen is now resting on top of the water-bearing formation which is usually a combination of sand and gravel, or alternate layers of sand and gravel. Deepening the well from this point is done by a sand bailer, which consists of a long cylinder with a flap valve at the bottom. In this cylinder is a plunger and the plunger rod is fastened to the cable that lifts and lowers the bailer. The bailer is lowered to the bottom of the well and the plunger allowed to settle to the bottom. The plunger is then raised and sucks into the bailer water carrying sand and gravel. As the sand and gravel are washed into the bailer, the weight of the screen with its gravel load on the cone causes it to settle a few inches. The bailer is pulled out of the well and emptied, and the process repeated. As the screen lowers, more screen is added at the top until the full amount of screen is in the well, then solid casing is attached. Finally the screen reaches the required level, usually a hard stratum underneath the water-bearing formation.



GRAVEL-WALL WELL AND OLD-TYPE WELL

Screen and Gravel Wall—This method of installation places the screen in its proper location with about a 6-in. gravel wall around it. A temporary pump is now placed in the well and water is pumped at a rate higher than the normal well production to draw in sand from the surrounding formation. The gravel wall settles, getting thicker in the water-bearing formation. More gravel is fed into the top until the well takes no more and the water clears of sand. Usually a gravel wall of one to two feet is left around the screen.

To illustrate the effect of this gravel wall, assume a well with a 24-in. screen section, 30 ft. long, delivering 400 gal. per minute. The upper half of the accompanying cross-section shows a well with a gravel wall and the lower half one of the old type. The curve shows the water velocity at different distances from the center of the well. This velocity is figured by assuming 40 per cent voids in both the gravel and sand.

The velocity curve has the general equation and shape of a hyperbola. It clearly shows the rapid increase in the velocity of the water as it approaches the well. The friction loss as the water flows into the well determines the drawdown and hence the distance that water must be lifted. The velocity of the water as it leaves the sand wall determines the size of sand grains and the amount of sand that will be carried into the well. The friction loss of water flowing into the well cannot be determined accurately. It will vary at least as the first power of the velocity and probably as some higher power of the velocity. If it varies as the first power of the velocity the friction-loss curve will have the same shape as the velocity curve. Even if this loss varies only as the first power of the velocity it is seen that the shaded portion of the curve is practically one-half of the total loss. This illustrates why the gravel wall construction causes such a marked decrease on drawdown of the pumping level in the well.

For a given well output the velocity at any given point cannot be changed. However, the location of the sand wall has been moved from 1-ft. radius to 2½-ft. radius from the center of the well. In the well chosen as example the water has a velocity leaving the sand

wall of 0.68 ft. per min. in the old-type well and 0.30 in the gravel-wall well. As the velocity at the sand wall has been reduced more than half, the amount of sand carried will be reduced to the finest particles which are pumped out and removed during the development period. Finally, the gravel-wall type of well eliminates sand troubles and reduces power costs.

Rigidity in Penstock Wye Secured by Simple Design

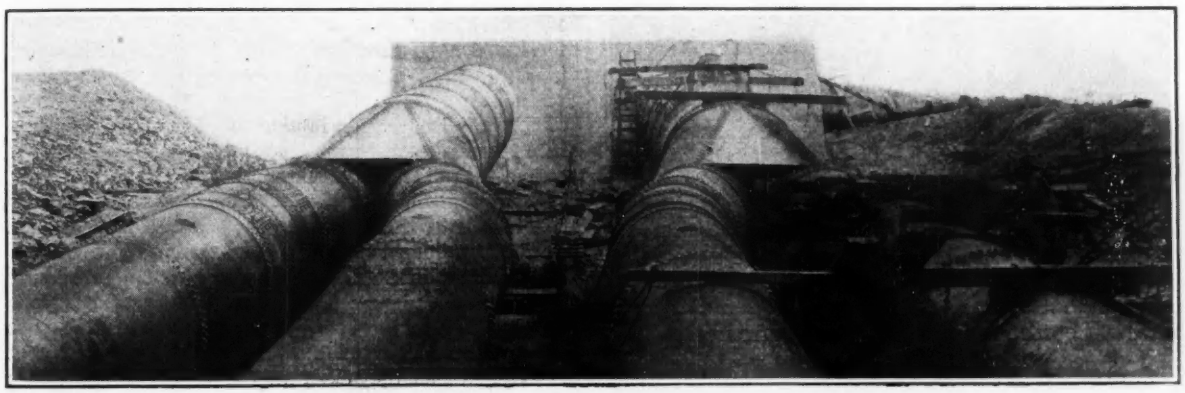
Riveted Steel Fork in Hetch Hetchy Penstock Made from Truncated Cones—Vertical Stiffener and Cover Plates Used

NEAR the upper end of the penstock supplying water to the Moccasin Creek power house on the Hetch Hetchy project two 98-in. riveted steel pipe lines by means of two Y's branch into four lines, each 66 in. in diameter. These wyes are just below a large concrete anchor block and are formed by riveted steel construction of the simple but rigid design shown in the accompanying illustration. The design was developed to adapt two truncated cones for combination into this special, and is therefore an adaptation of material on hand to a special purpose.

Generally speaking the plan was to cut a section of the same size from each cone and to bring the two cones together with the plane of the cut in common. A vertical stiffener plate in this plane riveted to both cones with cover plates above and below completes the main features of the construction.

Where the section was cut away from each cone the edges of the plates were curved sharply inward to make connection with the vertical stiffener. In order that rivets in this connection might be subject only to shear, a solid continuous layer of metal (varying in thickness to suit the stress) was built up by electric welding between the plates of the two cones just above the sharp bend near the connection. Thus, in effect, the plates of the two cones were connected independently of the stiffener plate. To make sure that there would be no bond and hence no transfer of stress from weld to vertical stiffener plate a copper strip was put in to cover this joint before welding began. Before making decision as to the thickness of metal to be welded into this connection, full-size sample sections were made up according to the method outlined in the foregoing and were tested to failure.

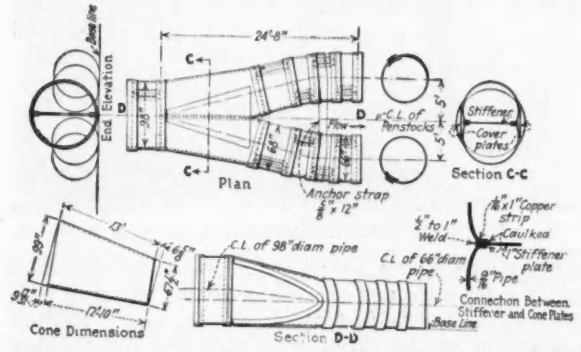
Just below the separation of the two branches of the wye a $\frac{5}{8}$x12-in. strap passes around both branches to hold them together and to prevent any separation due to lateral thrust. In order to get this band tightly in place, a second band, equipped with rods and turnbuckles for drawing it up tight, was temporarily put on a few feet farther away from the fork and tension was put on this by means of the turnbuckles until the permanent band could be fitted tightly to place and the rivets driven. Before the rivet holes were reamed out, 12-lb. sledges were used to secure a tight fit in the permanent band and where sledges on cold metal were not sufficient the band was first heated with torches so as to be sure that the curves "laid up" as desired.



LOOKING TOWARD ANCHOR BLOCK FROM BELOW WYES

In order to cut down the free span of the pipes (acting as beams) it was necessary to place a support under the legs of the wye but owing to the spreading movement of the two branches under temperature changes, the ordinary saddle support of course could not be used. Also due to the longitudinal movement in contraction and expansion, if the wye were allowed entire freedom of motion it would be subjected to heavy bending stresses. In order to meet these conditions a sliding anchor was designed. This consists of shoes, attached to the pipe, that slide on a set of castings embedded in the concrete. The shoes on the pipe are free to move lengthwise as the pipe expands and contracts, while fins projecting into the grooves of the castings in the concrete resist any lateral thrust.

Details of design on this wye were worked out by R. P. McIntosh, assistant city engineer, under the general direction of M. M. O'Shaughnessy, city engineer, San Francisco, Calif. The wye was built by the Western Pipe & Steel Co.



DETAILS OF THE WYE IN MOCCASIN CREEK PENSTOCK

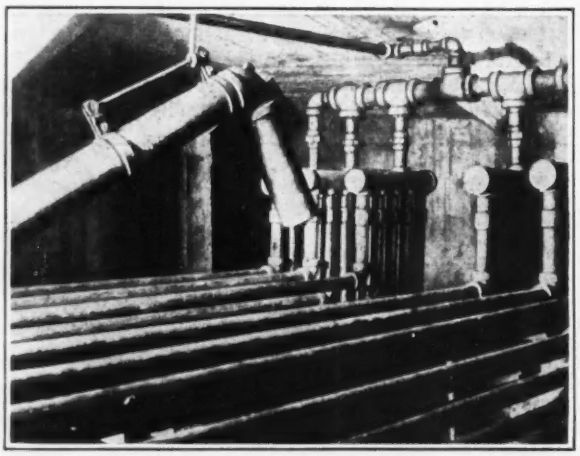
From Job and Office

Hints That Cut Cost and Time For the Contractor and the Engineer

Photographing Engineering Structures by Reflected Sunlight

By H. G. Overholt
Resident Engineer, Public Belt R.R., New Orleans, La.

EXCELLENT photographs may be taken in basements or underground rooms and in dimly-lighted spaces of any description by the simple expedient of



HEATING COILS PHOTOGRAPHED BY LIGHT REFLECTED FROM MANHOLE

passing a reflected streak of sunlight across the subject or area to be photographed. The only requirement is that a small beam of sunlight enter the space or that there be a window or other opening through which a ray of sunlight can be reflected onto the object. This condition can generally be fulfilled.

The camera is placed in the desired position, subject to the usual limitations imposed by the direction of the light, and focused, and the shutter is opened as for a flashlight or time exposure. The exposure is then made by playing a streak, not a spot, of reflected light back and forth across the field. The streak of reflected light is obtained by holding a small piece of bright tin, bent to an arc of small radius, in the beam of sunlight. A few trials will determine how the tin reflector should be held so as to throw a streak of light from the feet of the operator back across the room. A slow turn of the reflector will pass the ray across the field and the exposure is then made. If the sun is not strong several quick passes may be desirable, instead of one slower one.

The result is the same as would be secured by an exposure in full sunlight with a time of exposure equal to the time that the ray is allowed to rest on each point or portion of the object being photographed. In mathematical terms, an integrated exposure is made. In some ways this method is preferable to a flashlight or to ordinary snapshots in full light in that dull portions, as pipe lines for instance, may be favored by keeping the light on them longer than on brighter surfaces.

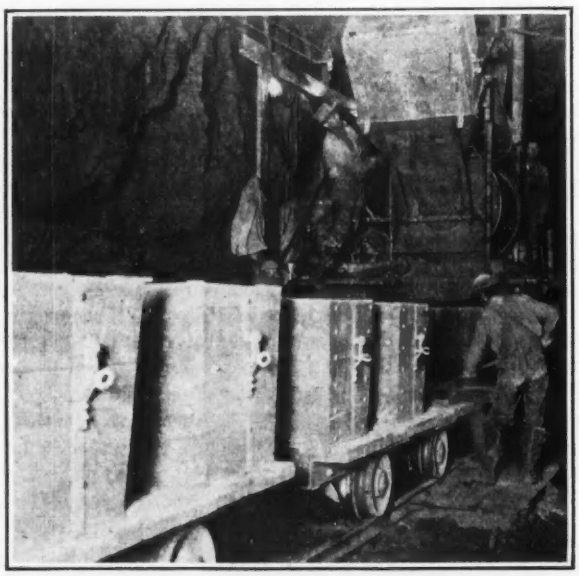
The photograph reproduced herewith is of a heating coil in an underground concrete oil storage tank, dark except for light entering at the manhole. The white portions at either end are concrete column faces, too strongly illuminated.

Batch Boxes Raised with Skip in Mixer-Charging Device

A SCHEME for speeding up concrete-mixing operations by lifting a batch box with the mixer skip was used successfully in placing concrete lining in the Florence Lake tunnel of the Southern California Edison Co. This plan eliminated the operation of dumping the dry material batches into the skip. The batch boxes were moved up as required into a position where the skip could raise them bodily so they would dump directly into the mixer—thus making the skip, in function, merely a chute.

The plan of operation is illustrated in the accompanying picture which shows a batch box dumping into the mixer while other batch boxes await their turn. The boxes were made of 2-in. plank reinforced with a strap of ⅜x4-in. iron, through which is bolted a 1-in. eyebolt. The inside dimensions of the box were 2x3 ft. in plan with a height of 2½ ft.; the ordinary batch containing 10 cu.ft.

On one side of the box metal straps were bolted with the upper ends curved outward to engage the lip of the skip. When the mixer was to be charged the skip was lowered until its edge came between these straps



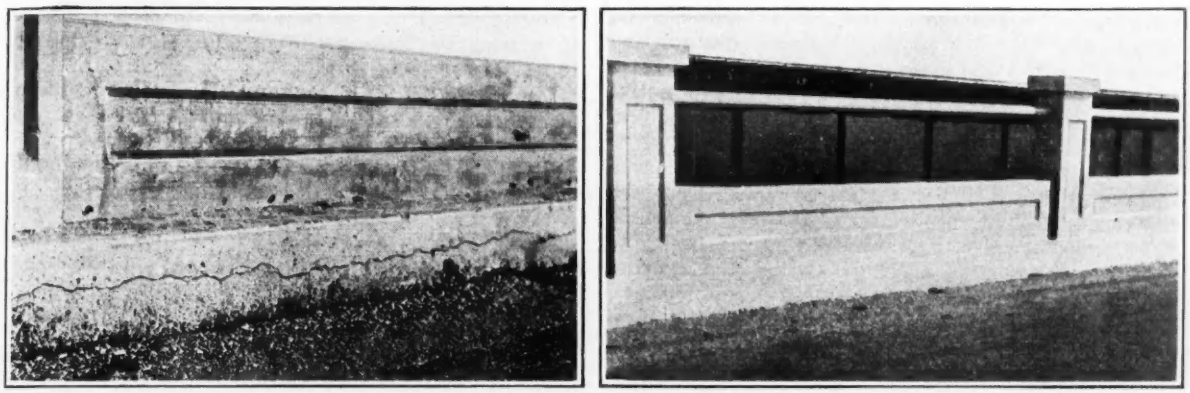
BATCH BOX DUMPING DIRECTLY INTO MIXER

and the side of the box; hoisting cables were hooked into the eyebolts and the cables drawn up until both sides of the box made contact with the skip. Further winding up of the cables lifted skip and box together and the materials slid down into the mixer.

Only comparatively simple changes in the manufacturer's construction were required to adapt the mixer mechanism to this special purpose and these were made on the job. The batch boxes were delivered on flat cars, three to the car, in trains that passed directly under the mixer platform, thus a train could be "spotted" as desired, moving ahead as the successive boxes were dumped and returned to the car empty.

Waterproofing a Reinforced-Concrete Highway Bridge

NUMEROUS cracks in the girders, deck and railing of the Santa Margarita River bridge on the Coast highway, in San Diego County, Calif., made it necessary to waterproof the structure to arrest deterioration. The bridge is located on the ocean front and spans tidewater, being at all times subjected to moisture and salt sea air. The structure was erected a number of years ago before the present exacting standards for reinforced concrete subjected to sea water or air were formulated. In numerous cases on the Santa Margarita River bridge salt moisture penetrated the concrete causing reinforcing bars to rust, thereby breaking and cracking the concrete.



WHEEL GUARD AND RAILING BEFORE AND AFTER TREATMENT WITH DAMP-PROOFING PAINT
The crack shown in the view at the left was first filled with a special crack filler before the damp-proofing paint was applied.

In the waterproofing visible portions of the structure were painted with a damp-proof paint with a dull-toned finish. Girders and the under part of the bridge were treated with petrolastic cement, air-blown asphalt having, it was believed, more elacticity than steam-blown asphalt. Petrolastic cement was applied with a paint spraying outfit, operating two air brushes. The air brush work was done first to avoid the possibility of spattering with the black petrolastic cement any of the hand-painted surface.

In order to obtain the proper consistency for application, the petrolastic cement was thinned by heating, and to it was added a liquid thinner composed of 75 per cent mineral spirits and 25 per cent benzole. The use of two parts of petrolastic cement to one part of liquid thinner gave the best results. On most of the bridge one coat of petrolastic cement was sufficient to fill the cracks and pores in the concrete surface. However, on several areas a second coat had to be applied. Paint was applied at the rate of approximately $\frac{3}{4}$ gal. per square yard.

Damp-proof paint was applied to the railing and sides of the bridge deck in two coats with hand brushes, after cracks larger than hair cracks had been filled with a special crack filler. For the primary coat, the paint was thinned with a special liquid in the proportion of 1 gal. of liquid to 5 gal. of paint, and was brushed well into the pores of the concrete. The first coat of paint was allowed to dry three days and then a second coat without the addition of the thinner was applied. One gallon of paint covered about 10 sq.yd. of concrete with two coats.

The work was done under the direction of E. G. Brassington, maintenance foreman.

The information contained herein was taken from a recent issue of the official bulletin of the California State Highway Commission.

Specifications for Reduced Drawings

By Lt. C. L. B. Anderson
Civil Engineering Corps, U. S. Navy, Norfolk, Va.

THE advantages of reduced-size contract plans bound together with the printed specifications are not generally appreciated. From the time the question was first agitated, about seventeen years ago, very little has been said as to the best size of reduced drawings to be bound with printed specifications. The description of the following scheme which has proven satisfactory may be helpful.

A few years ago an engineering company engaged in municipal engineering such as sewerage, sewage disposal, power and filter plants, etc., decided to adopt a new standard size for specifications, and a scheme for binding with the specifications copies of the contract drawings. Following what seems to be the consensus of opinion of the engineers who have considered this question, the 8½x11-in. size was adopted for the specifications. In order to conform better to standard paper sizes used by the printers, the actual trimmed size of the specifications was 8½x10¾ in.

It was a more difficult matter to determine the size of the reduced drawings. They must be large enough to be easily read and small enough to be readily folded into the specification. The ratio of length to width was fixed, however, by the standard size of the original drawings: such that nominal 36-in. tracing cloth could be used without waste. The most used size was overall 24x36 in. with a ½-in. margin outside the border line on three sides and 1½-in. margin at the binding edge, giving a sheet 23x34 in., within border lines—a size not too large for convenient field use and large enough

to allow the use of architectural scales. As far as possible scales of $\frac{1}{16}$ in., $\frac{1}{8}$, $\frac{1}{4}$, $\frac{1}{2}$ and 1 in. to the foot are used except for details.

With a reduction of $2\frac{1}{2}$ this size of drawing is made to fit the size of specifications adopted, and at the same time remains convenient for scaling. The reduced print is $9\frac{3}{16}$x$13\frac{3}{16}$ in. within margins. Using the shorter dimension as the binding edge and folding the prints once, they fit the size of the specifications conveniently. The $2\frac{1}{2}$ reduction changes the architectural scales noted above to engineering scales, the $\frac{1}{16}$-in. scale being transformed to a 40 ft. per inch scale and the $\frac{1}{8}$-in. scale becoming 10 ft. per inch.

Engraved plates were made of all standard drawings which would be used on several jobs, but all other drawings are reproduced by the cheaper stone-engraving process. As each set of drawings accompanying the specifications for a project numbers from two to thirty, it is found cheaper to send out to prospective bidders the reduced drawings bound with the specifications rather than the usual sets of blueprints.

If on examination of the plans and specifications a company wishes to bid provisions are made by which they can, if desired, obtain sets of full size blueprints. It is found, however, that some estimators prefer to work from the reduced drawings, for instance, figuring concrete quantities and taking off steel reinforcement. With the reduced prints it is possible to detach them and lay them out on a table or fasten them to a wall where the estimator has before him the entire set of plans. The accuracy with which drawings originally made to $\frac{1}{8}$ in. to the foot or larger scales can be scaled is surprising.

The advantage of the use of reduced drawings on construction work and the value of such sets of specifications and drawings as an office record deserves consideration. A trial of this system is recommended to engineers engaged in work where it is customary to send out plans and specifications to prospective bidders. They will find it more economical in the end and far more satisfactory.

Danger Sign for Construction Jobs

A PORTABLE warning sign that will meet the requirements of the general contractor and yet be sturdy enough in construction to withstand the severe jolts it will receive from the careless motorist, has been designed and put into use by the Herbert M. Baruch Corporation, member of the Southern California Chapter, Associated General Contractors of America, Los Angeles.

SIGN WARNS MOTORISTS OF CONSTRUCTION DANGER

The frame of the barrier is 5 ft. long, 3 ft. high and is constructed of $1\frac{1}{2}$-in. pipe, which has been joined together with ells and tees, assuring rigid construction. On the sign, which is made of heavy galvanized iron, and swings from the frame, the word "DANGER" in large red letters catches the eye of the approaching motorist or pedestrian and warns him of the street condition ahead. Below in smaller letters is the name of the firm, and above the frame is the A. G. C. emblem, 18 in. in diameter.

The accompanying photograph shows the details of the construction where sand, stone, steel, cement and a mixer are occupying a portion of the street immediately in front of the new $500,000 Masonic Club building now under construction in the downtown section of the city.

From Job and Office

Hints that Cut Cost and Time

Pavement Center Line Marker

ANOTHER device for marking the center line of pavements has been developed. This time it is the maintenance department of the California State Highway Commission that is responsible for the device, according to a recent issue of *California Highways*, the official publication of the highway department.

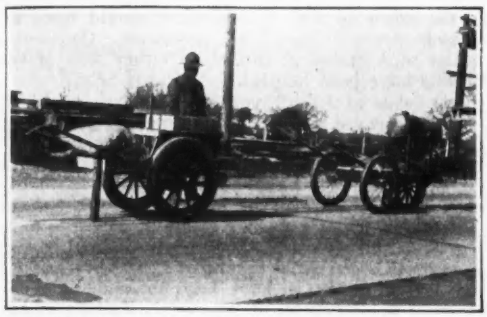
The device consists of two units, one for painting the line and the other for distributing sawdust over the fresh paint to prevent its being smeared over the pavement by traffic. Before the plan for covering the paint with sawdust was carried out, it was found practically impossible to keep traffic from spoiling the looks of the job. Hand sprinkling of cement was found too tedious and expensive. After considerable experimentation, the outfit shown herewith was developed by B. W. Bicksler, in charge of maintenance in Division 10.

The painting rig consists of a frame supporting the paint container and mounted on three wheels. The front or marking wheel is a discarded Ford wheel with a felt-covered rim. The other two wheels of the marker were taken from a discarded motorcycle and the paint container is an old truck gas tank. This tank was used as a pressure tank to spray the paint on the marking wheel at first, but this method proved unsatisfactory and an improvement was made in the machine whereby the paint is allowed to flow down a small pipe by gravity, pouring onto the pavement immediately in front of the marking wheel. A cutoff valve is attached to a long lever so it can be operated by the person pushing the machine. Behind the marking wheel two paint brushes are placed so as to smooth the paint and work it into the pavement.

The sawdust distributor consists of a bin for holding the sawdust mounted on a pair of old Ford wheels. Two small wooden wheels connected by an axle with an eccentric are fixed, so that they can be brought to bear against the large wheel. The eccentric is connected by a rod with a tin top under an opening in the sawdust bin, agitating it and causing the sawdust to fall onto the freshly marked paint. A burlap sack is dragged behind to spread the sawdust evenly. The

From Job and Office

For Contractor and Engineer



PAVEMENT MARKER FOR CALIFORNIA HIGHWAYS

line is kept straight by an outrigger with a small wheelbarrow wheel so placed as to be easily seen by the truck operator. It is run along the outside edge of the pavement as a guide. The marking machine is fastened to the front of the truck and the sawdust distributor to the rear. They may be adjusted to mark any width of pavement. Asphalt paint is made by dissolving asphalt in gasoline. A clean-cut job free from smearing is secured by using this apparatus.

Leveling Up Gasholder Landing Blocks

By A. H. T. Williams
Consulting Structural Engineer, Portland, Ore.

UNEVEN settlement of the tank of a gasholder belonging to the Portland Gas & Coke Co. created a dangerous condition which was corrected in the manner herein described. In consequence of the uneven settlement the lifts in landing on the blocks tilted over and the outer lift, being the first to land, tilted toward the second lift, and the second lift tended to rub on the edge of the cup of the outer lift endangering the rivet heads. The holder itself is about 144 ft. in diameter and the depth of water in the tank 35 ft. The distance between the outer lift and the inner wall of the tank is 12 in., but at the bottom of the outer lift is a 4-in. angle, limiting the space in which to work to about 8 in. between the toe of the angle and the inner face of the tank.

A survey of the tank was made and repeated three times to obtain as near as possible the exact levels of the tops of the landing blocks, variation between the highest and the lowest being 2¾ in.

Deciding as nearly as possible what thickness was required to add to the tops of the existing landing blocks, wooden blocks of this thickness were made and attached to the under side of the outer lift by clamps. The outer lift was then lowered until the wooden blocks rested on the existing landing blocks and observations made of the upper portion of the lift indicated that the dimensions used were almost precise. The lift was then allowed to rise to enable these wooden blocks to be taken off. By examination of the under side of the blocks it was possible to tell the exact position of the landing blocks and the amount of bearing that each block had received.

Cast-iron caps were then made and fitted over the top of the landing blocks. Attached to the underside were lugs, by which the caps were locked to the landing blocks after they had been lowered into place. The landing blocks themselves were 8-in. I-beams, with a 4-in. flange about 3 ft. long. To lower, by means of ropes, these cast-iron caps, weighing about 100 lb., and to be sure that they were in place, was the difficult part of the whole thing. This was accomplished by using a 2-in. pipe to guide the caps into place at their front end, and by supporting the tail end of the casting by ropes operated by men on the walkway.

As it was impossible to see what was being done, it was a question of feeling the whole way through. At first the progress was slow but after a while the men could place these caps accurately and rapidly. There were altogether thirty of these blocks and the whole of them were placed in the course of three weeks.

After the completion of the work, both the outer lift and the second lift were allowed to go completely down and landed on these blocks perfectly. Where previously

LOWERING BLOCKS TO CORRECT GASHOLDER TILT

they had rubbed each other, there is now 3½ in. of clearance.

The consulting engineers on this work were Blood and Williams and the contractor was W. W. Gabriel & Co.

Job and Office Notes

Threaded Pipe Joints which will be tight as soon as made up can be secured by coating the threads with zinc dust or lead filings and oil. A joint made up in this way does not have to "set" and will be easier to unscrew than one made with a joint paste. In tests conducted recently at the Bureau of Standards several joints were made up with lead filings or zinc dust and cutting oil, and proved to be tight at once under a water pressure of 8,500 lb. per sq.in. Joints made with paste leaked under a much lower pressure even after allowing 2½ weeks for them to set. There was but little difference in the performance of the lead and zinc joints, and since one or the other of these materials is easily obtained, this "kink" would seem to be of real value.

Letters to the Editor

This department aims to be a forum for the discussion of the views of engineers and contractors. The range of interest should be as wide as possible. Contributors are, therefore, asked to make their letters short.

Sheffield and Gem Lake Dam Failures

Sir—In your issue of June 25 two letters appeared under the caption "Drains under Earth Dams."

I am in thorough agreement with the practice recommended by Gardner S. Williams for the installation of drains on the downstream portion of earth-fill dams. Fifteen years ago I used such drains in the throttle dam, T. O. Ranch, New Mexico, with much success.

A saturated condition of any dam near the downstream footing is fatal, and is a certain promoter of failure. The installation of drains to relieve this condition is therefore a wise preventive against disaster. A toe of coarse gravel or rock in this location serves a similar purpose, and is quite as beneficial as drains; and in all the earth-fill dams I have made I have endeavored to have such a rock toe for drainage purposes on the downstream portion of the dam.

I have just inspected the Sheffield dam of the Mission Ridge reservoir of the city of Santa Barbara, which is 30 ft. in height, with a 20-ft. crest, upstream slope 2½:1 and downstream slope 2½:1, paved with concrete slabs 4 in. to 6 in. thick. A separate steel gate tower 15 ft. upstream from the toe wall connects with 200 ft. of 24-in. service line placed in a trench in puddled clay through the center of the highest portion of the fill. The concrete facing is built in 20x20-ft. articulated blocks with a tapered ½-in. to ¼-in. joint filled with asphalt and oakum.

The quake came at 6:42 a.m. on Monday, June 29. There is a fault line one-half mile south of the dam, and undoubtedly the vibrations from the fault line must have opened the joints, as wooden houses in the vicinity moved as much as 4 in. on their concrete foundations. The dam must previously have been partially saturated from leakage, as it had a depth of only about 20 ft. of water the morning of the quake, and a great mass of the center, about 300 ft. in length, slid downstream perhaps 100 ft., and much of the material was washed by the current from the 35 million gallons water contents into the ocean. If the downstream half of this dam had been drained and proper wells made for catching any moisture, and if concrete supports, 24 in. wide by 8 in. deep, had been placed under the concrete slab joints, there would have been no doubt as to the stability of this structure. Construction of the outlet pipe in cut or tunnel on either side of the dam would also have been helpful.

In your issue of July 2, you have an article which states that frost destroyed a buttressed arch concrete dam, namely, the Gem Lake dam in the Sierra Nevada Mountains. I do not believe this statement is a correct interpretation of the causes of failure. I have built a similar dam at Lake Eleanor, 4,660 ft. above the sea, with 40-ft.-span arches and buttresses, using a proper grade of concrete materials, sand, gravel, and rock, and there are no indications of wear and tear on this concrete structure; and the location is subject to severe frosts without any noticeable depreciation whatever in the concrete. I believe the failure of the Gem Lake dam is due, not to design of structure, but to defective granite dust and materials being incorporated in the sloppy overwatered concrete during construction. The excessive mica of some decomposed granites is a fatal defect in either sand or gravel and such material should not be used.

M. M. O'SHAUGHNESSY,
City Engineer.

San Francisco, Calif.,
July 9, 1925.

TWO VIEWS OF SHEFFIELD DAM BREAK LOOKING DOWNSTREAM AND ACROSS WASHOUT

Hydro-electric Power in Spain

In 1904 the Spanish Ministry of Agriculture, Industry and Commerce, gave the installed power as 132,000 hp., in 1917 384,000 and the present estimate is placed at 1,000,000 hp. with 300,000 hp. additional now being installed. The province of Catalonia is especially well favored in that its rivers are estimated to be able to produce 800,000 hp., most of which is primary power made possible by the large storage reservoirs which are available in the mountains in the central and north part of the province.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

State Highway Commissions May Be Sued

In Patent Case Judge Rules Suit May Be Brought to Compel Them to Fulfill Contracts

In a suit brought by Warren Brothers Co. against the Oregon State Highway Commission and several contractors to recover a royalty on the infringement of Warren Brothers paving patents, Judge Bean of the U. S. District Court for the district of Oregon, ruled that the highway commission could be sued, and overruled the contention that such a suit was a suit against the state and so in violation of the 11th amendment to the Constitution. In his decision Judge Bean said, in part: "It appears that in 1919 and 1920 the highway commission contracted with certain individuals for the laying of pavement, all embracing the same construction and under the same specifications, and in each contract provided that any royalty on patented pavement should be paid by the commission, and that it would indemnify and protect the contractors against damages on account of patent infringement. Among these contractors was one Oskar Huber, and after the pavement had been laid the plaintiff brought suit against Huber for infringement of patent, and damages. The attorney general of the state defended the suit, and after a trial the patent was declared valid in this court, and its decree affirmed by the court of appeals. Thereafter this suit was commenced against the highway commission and several contractors to compel the commission to comply with the law and its contract, and pay such royalties, and to be subrogated to the actual contractors.

"Motions to dismiss have been filed. On behalf of the commission it is contended that the suit cannot be maintained against it because it is in effect a suit against the state, which is prohibited by the Eleventh Amendment to the Constitution of the United States.

"There are almost innumerable decisions to be found in the books on this question, and authorities can be found supporting either view. It would be useless if not impossible to reconcile the authorities, and I do not attempt to do so. It is enough that in my opinion the great weight of authority as well as reason supports the rule that an action or suit may be maintained against a state agency to compel it to perform a plain official duty which the law imposes upon it and a contract which it has entered into in pursuance of the law.

* * *

"The duties imposed upon the highway commission by law and by its contract is to pay the royalties for the patented pavement used by the contractors, and to indemnify them against damages on account of the infringement of the patent, and it has a fund at its disposal for that purpose. The state has thus spoken through its laws, and the highway commission in disobedience thereof does not stand for the state within the rule giving it immunity from suit. Although not designated as a corporation or expressly clothed with the right to sue and be sued, it is nevertheless an agency of the state intrusted with all powers necessary to enable it to completely discharge the duties imposed upon it, and if it cannot be compelled to comply with the law and perform the contracts entered into by it in pursuance to law, the parties dealing with it are without remedy.

* * *

"The plaintiff alleges that the defendant had notice of plaintiff's patent before laying the pavement, and the contracts themselves impute such notice, and no further statement upon that subject is necessary.

"It follows therefore that the several motions should be overruled, and an order will be entered to that effect."

After the rendition of this decision, an agreement was entered into between counsel for Warren Brothers Co., on the one part, and the State Highway Commission and the attorney general acting as its counsel on the other part, whereby the sum of $225,000 was paid by the State Highway Commission to Warren Brothers Co. in full settlement of their claims for royalty on their patents, including the judgment previously obtained against Oskar Huber for infringement.

Engineering Fifty Years Ago

From *Engineering News*, July, 1875

IN NEW HAVEN, the sewers are cleaned by means of a sewer cleaning truck, the invention of Messrs. A. B. Hill and W. S. McHarg, Assistant Engineers. The truck carries two buckets and is so constructed that it can be readily adjusted to run in a sewer of any size, from 24 inches in diameter upwards. With this truck, two men can do as much work as ten men with buckets. The City Engineer of New Haven gives it as his opinion that in the sharp, clean sand and gravel of that locality, they have the materials for manufacturing the best cement pipe that can be made, and he prefers sewer pipe made in New Haven, with proper care, to the best Akron vitrified pipe.

Reclamation Crops and Repayments

Crops Best Since 1917—Moratoriums Refused and Back Payments Coming In Rapidly

Washington Correspondence

Returns from 1925 crops on reclamation projects promise to be greater than for any year since 1917, Dr. Elwood Mead, the Commissioner of Reclamation reports on his return to Washington after having visited many of the projects. The cherry crop alone on the Yakima project brought $700,000. Apricots sold for $95 a ton. Most pear contracts were on $75 basis. The President's refusal to lower the tariff on sugar has given new impetus to the planting of beets. The sugar beet, Dr. Mead points out, is particularly adapted to the irrigated farm.

The greatly improved agricultural situation has dispelled much of the gloom which has enshrouded the water users for several years, Dr. Mead says, and will have an important bearing on the success of the efforts now being made to get reclamation generally on a more business-like basis.

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In doing away with blanket moratoriums and insisting that all water users, who are able, must pay operation and maintenance charges, the Secretary of the Interior and the Commissioner of Reclamation have aroused loud protests but they are collecting charges at such a rate that extra help has had to be engaged at some points to receive the money. In one instance where it was represented that no one of 3,000 settlers could pay anything, all but 170 have paid. Relief is granted to individuals who can establish that they are unable to pay.

Despite the protests of some, the effect of the new policy has been to bring about much better relations with the water users. The great majority realize that these debts are like other debts and must be paid if the projects are continued.

Since Dr. Mead has been commissioner more than half of his time has been taken up in efforts to collect for water service. He feels that this service is comparable to the service performed by a railroad in carrying passengers, where payment must be made before the service is performed. For that reason all 1926 payments are to be required in advance.

Work Starts on Point Bridge at Pittsburgh, Pa.

The first caisson for one of the two river piers of the new Point Bridge at Pittsburgh, Pa., was towed to the site on July 21. This marks the beginning of work on this $2,300,000 project.

WASHINGTON NOTES

Construction work on the new union terminal at Cleveland is reaching a point where a decision must be made promptly as to the type of bridge which must be erected over the Cuyohoga River for the tracks which approach the terminal from the west. This decision will have an important bearing on plans for the straightening of the river.

Apparently either a high fixed bridge must be erected near Irishtown Bend or a bridge with a lift or draw span must be thrown across the proposed channel south of the Superior viaduct near the terminal. If the neck of land east of the channel under the Superior viaduct were cut through for a new river course, a high level bridge could not be built, it is stated, without expensive elevation of tracks on the east side of the river and major changes in the plans for the terminal itself. Judging from the position which the Chief of Engineers has taken on other structures, he is not likely to approve anything but a high level bridge, in view of the large amount of traffic that would be carried across the structure and the great tonnage that goes up the river.

Plans for straightening the river practically have been reduced to one of widening the stream along its present course at the bends; cutting through the neck of land south of Irishtown Bend in the vicinity of the plant of the Upson Nut Co.; or cutting through under the high part of the Superior Viaduct to the bend near the east bank in the vicinity of Third Street. The Chief of Engineers has at his disposal an appropriation of $5,000 for a survey of the river straightening project. He is prepared to make that survey as soon as the local authorities determine upon which of the projects is to be adopted.

The river and harbor act of 1917, which appropriated the $5,000 for the survey, also specified that the federal government is not to participate in the improvement of Cleveland harbor to an extent greater than $400,000. This does not permit Congress to appropriate that amount. Some are of the opinion that the appropriations committees will not want to consider any appropriation for that purpose, in view of the present policy under which the federal government constructs and maintains outer harbor works, while the local interests take care of inner harbor works as their share of the project.

Questions involved in these improvements at Cleveland are expected to be the subject of active consideration in the near future at the Corps of Engineers and before the congressional committees.

The Washington Water Power Co., of Spokane, Wash., has applied for a license for a project in Columbia River at Hayes Island. It is proposed to build one dam above the upper falls and another at the lower end of Hayes Island. This will make available 150,000 continuous hp. and 80,000 secondary hp., it is estimated.

Work Begun on Test Arch Dam in California

Foundation work for the test dam which will be built by a research committee of Engineering Foundation to investigate questions of strength of arch dams has been begun, according to a statement of the Foundation. Work on the dam itself is expected to begin in October. The structure is situated on Stevenson Creek, a tributary of the San Joaquin River, about 60 miles east of Fresno, Calif. It will be built first to a height of 60 ft. above bottom of foundation and later, after the preliminary tests, to a total height of 100 ft. The upstream radius of curvature will be 100 ft. and the thickness 2 ft. from the 30-ft. level to the top, while the lower part will splay out to a base thickness of 7 ft. 5 in.

Chicago Sidesteps Meter Problem

In spite of strong argument on behalf of the water-meter ordinance, backed by the mayor, the department of public works and engineering and commercial organizations, the Chicago aldermen have shown such strong opposition that in order to save the ordinance from defeat at the last meeting of the council its consideration was postponed until October. This opposition is almost entirely due to personal politics, the opponents fearing that they will not be re-elected if they go on record as favoring any check on the present reckless use and waste of water. In such an attitude they give no heed to the city's benefit or the warnings of the U. S. Government as to water restrictions. In order to reduce the opposition the meter rates had been modified materially from the original form noted in *Engineering News-Record* of June 18, p. 1033, but this proved of no avail.

Ottawa River Power Development to Be Undertaken Jointly

The establishment of a large zinc and lead plant by the Kingdon Mining, Smelting & Mfg. Co., which is controlled by the James Robertson Co., of Montreal, near Chats Falls, Quebec, on the Ottawa River, is reported to be in prospect. The project includes the development of water power at Chats Falls at an estimated cost of $2,000,000. The power site at Chats Falls has an estimated capacity of 100,000 hp. at ordinary flow. The Ottawa River is on the interprovincial boundary at this point and the power will have to be developed by co-operation between the two provinces. As reported in our issue of July 16, p. 117, the Ontario Hydro-Electric Power Commission was given authority by the Ontario Government to develop this and other sites on the Ottawa River, and it is now reported that the Ontario Commission will construct the dam for the power development at Chats Falls as a joint operation with the James Robertson interests and each party will construct its own power plant on opposite sides of the river.

Brigadier General W. D. Connor to Be a Major General

The Acting Secretary of War has recommended to the President the promotion of Brigadier General William D. Connor to the rank of Major General on Sept. 1, to succeed Major General Joseph E. Kuhn who will retire from active service upon his own application on Aug. 31 after forty years of service.

General Connor was born in Rock County, Wisconsin, on Feb. 22, 1874, and was appointed to the Military Academy from Iowa. Upon his graduation from West Point on June 11, 1897, he was assigned to the Corps of Engineers and served continuously in that arm until his appointment as Brigadier General on July 3, 1920. He participated in the capture of Manila and in the Philippine Insurrection. He was a member of the general staff from Sept. 24, 1912 until Sept 24, 1916. During the World War he served successively as assistant chief of staff, G-4, G.H.Q., A.E.F., as chief of staff of the 32nd Division, as commanding general of the 63rd Infantry Brigade, as commanding general, Base Section No. 2, A.E.F., as chief of staff of the S.O.S. and later commanding at Paris until American headquarters there were closed.

Since the World War he has served as commandant of the Engineer School, as director of the Inland and Coastwise Waterways Service, and as assistant chief of staff, G-4 in the War Department. He is at present in command of the American forces in China.

New Standardization Work

A subcommittee is being organized under the auspices of the American Engineering Standards Committee to develop a uniform method for rating the water power of rivers, according to an announcement of the committee. Ratings in use at the present time differ widely, some being based on minimum flow, others on equalized flow, etc., and in consequence, comparisons of power resources result in much confusion. The development of a single standard rating method is expected to eliminate this trouble.

Standards for cold-finished shafting and square and flat shafting keys, recently approved as tentative American standards by the committee, are being published by the American Society of Mechanical Engineers. They cover shaft diameters from ½ to 6 in. (machinery shafting) and 1⅛ to 5⅛ in. (transmission shafting). Stock lengths of 16, 20, and 24 ft. are recommended. The tolerances are negative, representing the maximum allowable variation below nominal size.

Engineer on Fort Worth City Plan Commission

Among the five members of the newly appointed City Plan Commission at Fort Worth, Texas, is F. J. Von Zuben, a former city engineer. The other members are the district attorney, R. K. Hanger, two realtors and a "laundryman."

Reclamation Bureau States Policy on Landholders' Payments

An important statement has just been made by the Bureau of Reclamation, outlining its policy with respect to requiring the water users to take over the operation of federal reclamation projects as a condition precedent to applying the relief measurers authorized by the last Congress (fixing construction repayments at 5 per cent of average gross income and permitting postponement in special cases). The statement deals with the Boise project, on which a wholesale request for putting off payments was recently denied by the Commissioner of Reclamation. It includes an intimation that foreclosure proceedings will be instituted against landholders who refuse to pay though able to do so. In part it says:

(1) That a contract will be negotiated with the Nampa & Meridian Irrigation District which will grant relief of the following kinds: (a) Provide for future construction payments on the basis of five per cent of the average gross acre income. (b) Suspension of construction payments for one year may be permitted in cases where found to be absolutely necessary, but no blanket moratorium will be granted.

(2) A similar contract will be made with the Black Canyon Irrigation District covering the lands under the Notus Canal.

(3) If the lands of the Arrowrock Division not now included in irrigation districts, are organized as an irrigation district and the organization of the district confirmed by decree of court not later than April 1, 1926, a contract similar to the one with the Nampa & Meridian Irrigation District will be authorized with the new district.

(4) Should such district not be organized by April 1, 1926, the Board of Directors of the Nampa & Meridian Irrigation District will be requested to permit the landowners of the unorganized part of the Arrowrock Division, who may desire to do so, to petition their lands into the Nampa & Meridian Irrigation District.

(5) Under no condition will any contract be made with the Payette-Boise Water Users' Association, or with either of the two boards of that organization.

(6) Landowners who insist on keeping their lands out of a district organization will be considered to be satisfied with their existing contracts and will be expected to pay accordingly.

(7) There will be no change in the ruling heretofore made in regard to the payment of drainage charges. The present ruling permits payment of these charges in five monthly installments. In the great majority of cases the payment now required in order to secure water is less than $20 and in many cases less than $10.

(8) Our attention has been called to a number of cases of which the following is an example:

One of the water users, who is also a member of one of the boards of directors of the Payette-Boise Water Users' Association, who owns one of the best farms on the Wilder bench, and of which there are no better anywhere in the United States, and who also has a salary as road supervisor of one of the counties of the project, is reported to have recently purchased an automobile, but is refusing to pay the government a charge of $17.10 for water, and has made no construction, or operation and maintenance payments since 1919. It is expected that foreclosure suits will be filed in cases of this kind, and other cases where it appears that water users are able to make the required payment, but are refusing to do so.

(9) The litigation recently initiated by the arrest of the government officers for performance of their duties in carrying out the provisions of the Federal law, and also the civil suits started by the representatives of one of the factions of the water users, will be carried to final judgment in the courts. The government and the government officers will abide by the final decision of the courts and the parties who have instigated this litigation will also be required to abide by the final decision of the courts.

Statue of John F. Stevens on Crest of Continental Divide

A statue of John Frank Stevens, the engineer who found the pass through the Rocky Mountains by which the Great Northern Ry. crosses the continental divide, was unveiled at the summit of the pass on July 21. The inscription on the base reads: "John Frank Stevens, December 11, 1889." This is the date upon which Mr. Stevens, then construction engineer for the Spokane Falls & Northern Railway Co., now part of the Great Northern Ry. Co., deserted by the two Indian guides who had set out with him from Assinniboine to find a route through the Rocky Mountains, and handicapped by the loss of his pack mule which had died on the way, reached the summit of the pass.

"JOHN FRANK STEVENS, DECEMBER 11, 1889"

Open Chicago's New Union Station

Formal opening of the new Union Station at Chicago by Mayor Dever and Samuel Rea, president of the Pennsylvania R.R. and the Chicago Union Station Co., took place on July 23, when the mayor, with city officials, railway officers and a party of engineers and other guests, made an inspection trip through the station, after which a lunch was served in a large room which is to be fitted up as a cafeteria. This station is unusual in its track plan, having two sets of stub tracks end to end, with the main concourse between them as described in *Engineering News-Record* of Dec. 6, 1923, p. 928. With a cost of about $60,000,000 for the station and headhouse, the total cost due to terminal rearrangement has been about $95,000,000, including a mail terminal building and three freight terminals to replace facilities wiped out by the new improvements, besides extensive street and utility changes. J. D'Esposito is chief engineer of the Chicago Union Station Co. In a speech at the dinner the mayor referred to the two other great local terminal projects. The Illinois Central R.R. is already committed to the construction of a large station and it is still a question whether a group of railroads now using old stations will unite in using this Illinois Central station or will build yet another terminal for their joint use.

Seaboard Extension to Miami, Fla. Now Virtually Assured

Extension of the Seaboard Air Line R.R. from its present terminus at West Palm Beach to Miami, Fla., a distance of approximately 50 miles, is now virtually assured by the offer of numerous parcels of land at Miami to be used as railroad right-of-way. Recently the president of the Seaboard Air Line announced that on account of the exorbitant price that has been put upon parts of the right-of-way it was endeavoring to secure in order to extend to Miami, the railroad company would be compelled to give up any idea of building the extension. Since that time numerous parcels of land have been offered to the railroad company and the president of the company has now announced that subject to certain conditions affecting part of the right-of-way still to be obtained and terminal arrangements at Miami, also subject to the approval of the Interstate Commerce Commission, the Seaboard Air Line will build the extension to Miami. No trouble in fulfilling the conditions is anticipated.

Employees of Municipal Utilities Exempt from Income Tax

In a suit brought by an employee of the street railway department of Detroit, Mich., against the Collector of Internal Revenue, Judge Charles C. Simmons of the Federal Court of Michigan, in a recent decision, ruled that the Federal government could not collect an income tax on the pay received by an employee of the street railway for such service. Judge Simmons said, in part:

"Plaintiff contends that he is specifically exempted from the payment of income tax upon his salary by the express provisions of law, and relies upon subsection 7 of subdivision (b) of said section 213, title II, part II, of the Revenue Act of 1921. The applicable language of such subsection is as follows:

"'Income derived from any public utility or the exercise of any essential governmental function and accruing to any state, territory, or the District of Columbia, or any political subdivision of a state or territory.'

"It must be perfectly clear from the reading of the language above quoted that the income exempted and referred to in the subsection is the income of the municipality, and not the income of the employee. I conclude therefrom without further argument or citation that there is no specific exemption of the plaintiff's income derived as salary from the municipal street railway by virtue of the section of the act above quoted.

"Plaintiff, therefore, is compelled to rely for his exemption, if he has any right to such exemption, upon such limitations upon the taxing power of the government of the United States as result from the implications of the Constitution of the United States, and the essential nature of the sovereignty of the state in its relation to the federal government. This question is not unattended with difficulty."

* * *

"We are confronted at the outset with the question as to what activities of the state and of its political subdivisions constitute an exercise of its proper and essential governmental functions, and what activities do not, and we are confronted also with a consideration of the dual nature of municipalities. That the city has a dual character, and possesses two kinds of power, is not now questioned. A municipality is clothed with power that is governmental and public, and to the extent that such power is held and exercised it is clothed with sovereignty. It also possess power that is private, and to the extent that such power is held and exercised the city is a legal individual."

* * *

"What are the criteria that are to be applied to a municipal activity in order to determine whether such activity is the result of an exercise of an essential or proper governmental function, or whether it is undertaken by the municipality in its private capacity? It is a delicate question and beset with difficulties. It has been held that businesses voluntarily conducted by a municipality, such as the furnishing of water for domestic purposes, gas, electricity, or other commodities (in some cases where the furnishing was for either public or private use), stand on the same footing as like business conducted by a private corporation.

* * *

"It might seem from the foregoing that it should be a simple matter to determine that the operation of a street railway by a municipality is an exercise of its private, and not of its governmental functions. A careful consideration, however, of a number of important cases dealing with this and analogous situations, and of illuminative expositions by authoritative textwriters, who have considered the historical development of public highways, leads to the conclusion that highways and means of intercommunication in which the whole community is interested have been from the earliest times the peculiar concern of governments."

* * *

"Another consideration must contribute to this view. It is impossible to conceive of the existence of the modern city of 1,000,000 or more inhabitants without some system of rapid transportation. The street car system of a modern city, whether its cars are operated upon the surface, overhead, or underground, constitutes the veins and arteries of the city necessary to its very life. Upon its proper functioning depends inevitably the efficiency of government in preserving the peace, protecting property and health, and preventing nuisances. Without it the city cannot exist. Without it the government cannot function in any of its essential respects. Must it not be said, then, that the provision for such a street railway system, whether operated by the municipality or by private corporations, and for the regulation and control thereof, is a governmental function, and does it become any less a governmental function if the city itself operates the system instead of permitting it to remain in the hands of private persons or corporations? The decision and the reasoning in the case of U. S. v. King County, supra, seem to answer these questions."

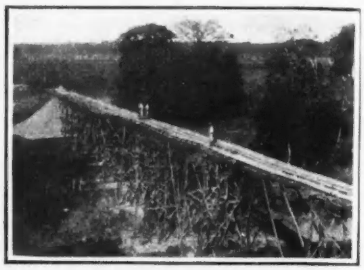
* * *

"I conclude from the foregoing that the maintenance and operation of a street railway system in connection with the public highway by a municipality is an exercise of a strictly governmental function, and that by the implications of the Constitution of the United States the government of the United States is not authorized to tax the income derived by any employee of the Detroit Municipal Street Railway, and in such maintenance or operation, and that such employee, as to such part of his income as is derived from his salary as such employee, is exempt from the Income Tax Laws of the United States. Judgment will be entered in favor of the plaintiff in accordance with this opinion."

This decision is in opposition to the ruling of the Solicitor of Internal Revenue of September, 1924, noted in *Engineering News-Record*, Jan. 15, 1924, p. 106, in which it is held that the compensation of an employee of a street railway owned or operated by a municipality is not exempt from federal income tax upon the theory that the operation of a street railway is not a governmental function of a city.

Railroad Construction in Central America

Construction operations on the Salvador-Guatemala R.R. in Central America are now proceeding on a large scale. Over 250 miles of the new line which will connect the Guatemala system of the International Railways of Central America with their system in Salvador are included in the new work.



TEMPORARY TRESTLE FOR MAKING A HIGH FILL

TYPICAL SIDE HILL WORK

The railroad will extend from Zacapa, a division point on the Guatemala system to San Salvador, capital of the Republic of El Salvador. It will also have some branch lines. The completion date is scheduled for early 1927. The Guatemala division of the work is over 40 per cent completed while the Salvador division, due to a late start, is only about 20 per cent completed. This joining of the two railroad systems will create a new trans-continental railway extending from the Port of La Union on the Pacific to Puerto Barrios on the Atlantic.

J. F. Shaw is chief engineer of the International Railways of Central America. The contractors on the work are R. W. Hebard & Co. and Kielhauer & Rodezno.

Experiment in Non-Skid Pavements Made at St. Louis

An experiment in street surfacing designed to reduce automobile skidding to a minimum is being made by the director of streets and sewers of St. Louis, Mo. A section of pavement 20 ft. wide on the steep part of Washington Boulevard is to be laid with a bituminous pavement on which will be spread a layer of crushed tough rock. This layer is then to be rolled into the surface of the pavement until the surface is even and suitable for ordinary traffic. It is hoped that this will result in a surface that will present considerable resistance to skidding.

Engineering Societies

Calendar

Annual Meetings

NEW ENGLAND WATER-WORKS ASSOCIATION, Boston, Mass.; Annual Convention in connection with trip on St. Lawrence River, Sept. 8-11, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Fall Meeting, Montreal, Que., Canada, Oct. 14-16, 1925.

AMERICAN PUBLIC HEALTH ASSOCIATION, New York City; Annual Convention, St. Louis, Mo., Oct. 19-22, 1925.

AMERICAN SOCIETY FOR MUNICIPAL IMPROVEMENTS, Lakeland, Fla.; Annual Meeting, Des Moines, Iowa, Oct. 26-30, 1925.

The Highway Research Board of the National Research Council will hold its fifth annual meeting at Washington, D. C., Dec. 3 and 4, 1925. The program for the meeting is being prepared and will be announced at a later date.

Personal Notes

MAJOR GENERAL MASON M. PATRICK, chief of the Air Service, whose four-year term will expire in October, has been recommended to the President for reappointment for a second period of four years. General Patrick served with the Corps of Engineers from his graduation from West Point in 1886 until in May, 1918, he was made chief of the Air Service of the A. E. F. His service during the World War, previous to this appointment, was first as chief engineer of the lines of communication and then as director of construction and forestry.

G. B. ARTHUR, Chicago, Ill., district manager of the Central Division of the National Lime Association, and a trained engineer, has been appointed assistant to the president, with direct general charge of all scientific, technical, research, field and general publicity work of the association and its divisions.

H. L. SANBORN, hydraulic and electrical engineer of the Abitibi Power & Paper Co., Iroquois Falls, Ontario, has been appointed manager of the Abitibi Electrical Development, a subsidiary of the former company, to handle the plant at Island Falls, recently taken over from the Hollinger Consolidated.

DAVID W. SMYSER, York, Pa., a graduate of the University of Michigan, has recently been appointed to the engineering organization of Gannett, Seelye & Fleming, Engineers, Inc., Harrisburg, Pa.

HARRY JESSEN, chief deputy city engineer of Salt Lake City, Utah, has been appointed acting city engineer vice SYLVESTER Q. CANNON, whose resignation will become effective on July 31.

FRASER S. KEITH, formerly secretary of the Engineering Institute of Canada, who resigned from that position to become manager of the department of development of the Shawinigan Water & Power Co., in January, but who remained with the Institute in an advisory capacity, has now severed his connection with the Institute in order to devote his entire time to his new work.

DR. C. E. A. WINSLOW, professor of public health, Yale School of Medicine, and editor of *The Nation's Health*, retires as editor of this paper and is succeeded by Dr. Frank L. Rector, medical investigator for the National Industrial Conference Board.

CHARLES F. CHASE has been elected president of The Berlin Construction Co., Inc., Berlin, Conn., to succeed the late GEORGE H. SAGE. Mr. Chase has been chief engineer of the company since its organization twenty-five years ago.

H. A. RANDS, formerly chief construction engineer for the Pacific Electric Power Co., Portland, Ore., has joined the engineering staff of the Hammon Consolidated Gold Fields and has gone to Nome, Alaska.

BERNARD L. CROZIER, newly appointed chief engineer of Baltimore, and head of the new municipal Department of Public Works, under which all the engineering branches of the city government are grouped, has been appointed a member of the Baltimore Traffic Survey Commission. This commission has been named to make plans for a complete survey of the traffic conditions in the city. When the commission was formed Steuart Purcell, then chief engineer of the city, was appointed the municipal representative. Mr. Crozier takes his place. The changes in the engineering department of Baltimore were given in last week's issue, p. 156.

FRED L. BOCK, for the past eight years engineer for the Missouri Inspection Bureau has resigned effective August 15 to accept the post of chief industrial engineer for the International Shoe Co. For the Missouri Inspection Bureau Mr. Bock had charge of the town fire protection work, inspecting construction of water-works, main extensions, fire fighting equipment, etc. Prior to joining the bureau he served as an engineer for the St. Louis Water Department. His new duties will be in connection with the mechanical and power departments of the shoe company.

R. W. WILLS has been appointed division engineer of the South Central Division of the Kansas State Highway Commission. Mr. Wills has been resident engineer of Jefferson County, Kansas.

LEO SILER has been appointed assistant division engineer of the Northeastern Division of the Kansas State Highway Commission with headquarters at Topeka. Mr. Siler has been assistant county engineer of Atchison County for the past four years; prior to that he was an assistant engineer with the Kansas Engineer Co.

Obituary

FREDERICK MAYER, an engineer on the state highway between Hillsdale, N. Y., and North Hillsdale, died July 14 in the Hudson, N. Y., hospital from injuries suffered in a collision of trucks on the highway. Mr. Mayer was 35 years of age and had been employed by the New York State Highway Department for several years.

CHARLES W. EATON, civil engineer, of Haverhill, Mass., died July 20 at Tacoma, Wash., of a heart attack. Mr. Eaton was educated at Andover Academy and at the Massachusetts Institute of Technology, where he graduated in 1885. Later he was an instructor there and also at the Pratt Institute of Engineering, New York. As a civil engineer he served on construction for government harbor work, notably the harbor at San Juan, P. R., dredging of Mobile Bay and other works on the Gulf Coast. He made many gifts to technology for the benefit of students and maintained a summer camp for technology students at East Machias, Maine.

S. D. KILPATRICK, member of the firm of pioneer railroad builders of Kilpatrick Bros., which constructed considerable portions of the Union Pacific, Central Pacific, and Oregon Short Line Railroads, died at Beatrice, Neb., July 18, in his 66th year.

GEORGE DARLING, president of the engineering firm of Darling Bros., Ltd., Montreal, Canada, died at his summer home at Hudson Heights, July 15, aged 59 years.

GEORGE HENRY SAGE, president of The Berlin Construction Co., Inc., of Berlin, Conn., died suddenly at his home in West Hartford, Conn., June 29. Mr. Sage was born in Berlin, Conn., 61 years ago. The early portion of his business career was spent with the Berlin Iron Bridge Co. When this company was absorbed by the American Bridge Co., he assisted in organizing The Berlin Construction Co., with which he was connected for twenty-five years, the last fifteen years being its president.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

American Road Builders Convention

The 1926 convention and road show of the American Road Builders Association will be held in Chicago on Jan. 11-15. Charles M. Upham, of the State Highway Commission, Raleigh, N. C., is convention manager. This is merely a preliminary announcement of the convention and road show, concerning which more detailed information will be published at a later date.

Paving Brick Varieties Reduced

The 3 x 3½ x 8½ in. Dunn wire cut lug brick has been eliminated as a recognized variety by formal action of the board of governors of the National Paving Brick Manufacturers' Association. The following sizes and types which constituted more than 80 per cent of the industry's business in 1924 are listed as recognized varieties for the ensuing year:

3 x 4 x 8½ in. Plain Wire Cut (Vertical Fibre Lugless).

3½ x 4 x 8½ in. Plain Wire Cut (Vertical Fibre Lugless).

4 x 3½ x 8½ in. Repressed Lug.

4 x 3½ x 8½ in. Wire Cut Lug (Dunn).

The formal action of the board of governors came as a result of a recommendation made by the Permanent Committee on Variety and Standards for Vitrified Paving Brick and adopted at its meeting on March 25.

Business Notes

GENERAL ELECTRIC CO., Schenectady, N. Y., received orders for the three months ending June 30 amounting to $66,468,992 compared with $71,219,984 for the same period in 1924, a decrease of 7 per cent. For the six months of the present year, orders total $150,315,228, compared with $144,707,887 for the first half of 1924, an increase of 4 per cent. These figures are according to a statement made on July 13 by Gerard Swope, president of the General Electric Company.

MARQUETTE CEMENT MFG. CO., Chicago, announces the appointment of Sellar Bullard as a vice-president of the company. He was formerly with F. B. Hitchcock & Co.

WESTINGHOUSE ELECTRIC & MFG. CO., will soon start the erection of an 11-story office building at its East Pittsburgh works. The new building will cost approximately a million dollars. Small buildings on the site of the new structure have been razed, and erection of the building will be completed within a year. The new building will centralize the office forces of the various departments which are now scattered throughout the factory and will add 175,000 sq.ft. to the present office floor area.

D. S. MCAFEE, manager of the Sanitary engineering department of the Dorr Co., New York, has been appointed general sales manager and will in future direct the sales work of all departments of the company in the United States, Canada and Mexico.

PENN METAL CO., Cambridge, Mass., is building a new plant at Parkersburg, W. Va., which will be devoted exclusively to such products as metal lath, rib lath, cold rolled channels and allied fireproof products. A. V. Spinosa, vice-president, Penn Metal Company, will be in charge of the Parkersburg plant.

NATIONAL SLAG ASSOCIATION, Cleveland, Ohio, has recently established a fellowship in Highway Engineering at the University of Michigan. The fellowship is under the direction of the division of Highway Engineering and Highway Transport of the university, and provides for the investigation of an approved subject relative to the utilization of blast furnace slag in the construction and maintenance of roads and pavements.

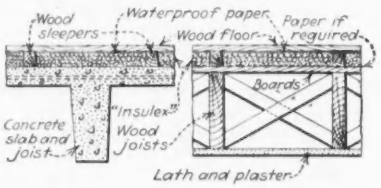
RAYMOND B. HOSKEN has been appointed general sales manager of domestic sales for the Sullivan Machinery Co., Chicago. Mr. Hosken has been assistant to Howard T. Walsh, vice-president in charge of sales, for the past four years, prior to which he was Australasian manager with headquarters at Sydney, N.S.W.

AMERICAN TAR PRODUCTS CO., INC., announces the removal of its general offices from Chicago to the Union Trust Building, Pittsburgh.

Equipment and Materials

Heat and Sound Insulation

A light weight cellular material known as Insulex or mineral cork, which is made and poured in place like concrete, is being introduced by the Illinois Asbestos Products Co., Chicago, for insulation against heat and sound as in the covering, lining or packing of roofs, floors, walls, tanks, piping, cold-storage rooms, industrial ovens and various similar purposes. It can be used also for interior partitions, while to meet special requirements, it can be cast in molds or forms and used as precast blocks. The Insulex in powdered form is added to water and begins to expand like yeast until it makes a thin grout which in a few minutes may be poured in place. It sets in about twenty minutes and then hardens into a permanent cellular structure. The lighter the weight the more effective is the insulation, due to the open texture of the material. When the main purpose is insulation and the Insulex will be protected by other covering, the weight may be as light as 12 lb. per cu.ft. of finished product and the insulating efficiency is said to be then nearly as great as that of cork. For floor and

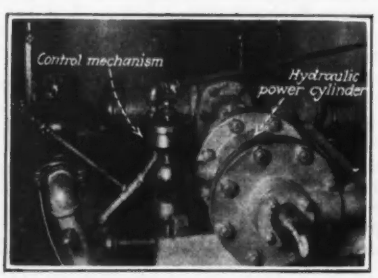


roof filling, and where used to bond brick or tile walls, the weight is about 24 lb. per cu.ft. This heavier mixture is strong enough to be walked upon within half an hour after being poured. For partition filling, one side of the studding is covered with plaster board or similar material and on the other side this board is carried up as the liquid Insulex is poured, the courses not exceeding 15 in. in height and being poured at half-hour intervals so as to be strong enough to carry the successive courses.

Automatic Valve Control Device Eliminates Water Hammer

A device that will automatically open gate, butterfly or check valves as soon as the pump builds up the required pressure or will automatically close them as soon as the power is shut down is a new product of the Chicago Valve & Hydrant Co., Chicago. The equipment consists essentially of the control mechanism proper and a hydraulic power cylinder. The piston of the control, governed by the pressure and velocity in the supply and discharge pipes, controls the flow of water which actuates the piston in the hydraulic power cylinder. The piston rod in the power cylinder is attached to the stem of the valve. The valve opens when the pressure on the supply side of the piston in the control mechanism is greater than that on the discharge side of the piston, so that water flows to the proper side of the piston in the hydraulic power cylinder. Closing of the valve is effected when flow of water stops.

The closing operation is made very rapidly in order to close the valve while



the water is in "dead" position. At the moment "flow" ceases and before "reverse-flow" begins, the valve is about 95 per cent closed. This condition is claimed to eliminate water hammer. A further advantage is that the control will automatically open and close valves at any predetermined rate of flow when a break in the mains would ordinarily drain the supply.

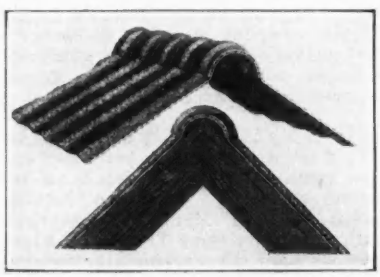
About half of the full time of closing the valve is used to ease the valve into the seat. The flow is practically cut off at that time, so that the seat and seat-rings of the valve are spared the wear and damage caused by pressure in operating gate valves by some older methods.

The control device is not only suitable for operating a hydraulic power cylinder as described above but may also be used to start or stop any kind of valve control mechanism that is operated by electricity, steam, air, etc. Although this control operates automatically, it can also be operated manually permitting operation of valves whenever desired.

New Corrugated Sheet Roofing Fits Ridge of the Building

A new type of sheet steel roofing, in which the sheet and the ridge roll are combined in one solid piece, has recently been announced by the Milwaukee Corrugating Co., Milwaukee, Wis. This invention is credited to Louis Kuehn, president of the company, and is known as Kuehn's ridge sheet.

This type of sheeting saves the cost of an extra ridge roll, and, in addition, is claimed to be stormproof, since there is double protection on the ridge of the roof, the sheet on each side of the

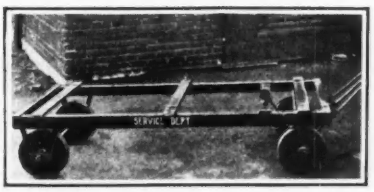


ridge having a curved end. The sheets are self-adjustable to any pitch of roof and are furnished in 1¼ and 2½ in. corrugations in 10-ft. lengths. Gages that are available consist of Nos. 29, 28, 27, 26, and 24.

New Applications of Electric Welding

Welded hand trucks are utilized by the Lincoln Electric Co., Cleveland, for its portable "Stable-Arc" welders and to transport parts and materials about the plant. The trucks are built by welding structural steel together and the company believes that they are several times stronger than those made of cast iron. At the same time, they weigh less than either cast iron or riveted trucks. The sides of the wheels are two disks welded to the tread which is a circular band with ends welded together. At the center a piece of tubing is welded and machined internally to serve as a journal for the axle and ten roller bearings.

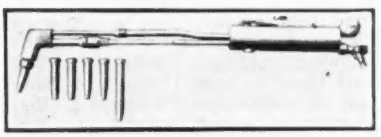
Application of welding has also been made to the fabrication of machinery



bases for pump, blowers, hoists and steam shovels. The use of steel shapes in place of castings has only been made possible by the perfecting of electrical welding machines.

Low-Pressure Welding Torch

A welding and cutting torch that will operate on either high or low pressure is being manufactured by Alexander Milburn Co., Baltimore. The torch is especially constructed to operate with low pressure acetylene gas, city gas or hydrogen. Welding and

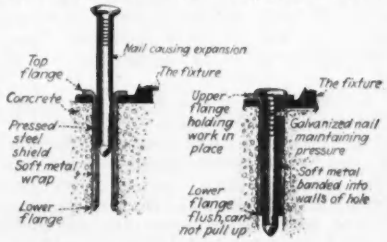


cutting are performed by interchanging the tips. These tips are made of copper, and interchangeable with a large number of low pressure torches of other makes. The Milburn torch is made of bronze forgings and special seamless tubing.

Nail Used Instead of Bolt in Expansion Shield

A new device for fastening metal fixtures to masonry consists of a soft metal wrap surrounding the lower flange of a galvanized steel shield into which a nail, instead of a screw or bolt, is driven bonding the soft metal wrap into the sides of the hole. Both the wrap and shield are split for expansion. The shield is flanged top and bottom, the top flange holding the load while the bottom flange is securely locked in when the nail is driven home.

The fixture that is being installed may be used as a templet because the correct size drill is of smaller diameter than the mounting hole. This expansion unit is known as the "Dryvin" and is manufactured by the Star Expansion Bolt Co., 147 Cedar St., New York.



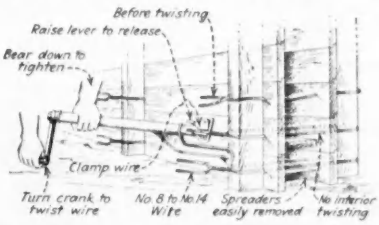
Dryvins are made in seven sizes from ⅜ x ¾ in. to ½ x 2¼ in. They are designed for a maximum working load of 1,200 lb. and are claimed to be 30 per cent cheaper than the ordinary screw expansion bolt.

New Paint Adheres to Creosoted Wood

To meet a demand for a paint that will adhere to creosoted lumber, the Jennison-Wright Co., Toledo, Ohio, has produced Kreolite Insulating Koating. The paint is suitable for such applications as guard rails along highways, signposts, railway crossing gates, fence posts and for marking aisles in factories having creosoted floors. The paint remains in condition to be applied with a brush at all atmospheric temperatures, and dries in from two to three hours. It is available in silver, orange and black, which colors can be obtained with one application to the creosoted surface. Any other color desired may be painted on after the first application.

Tool Eliminates Twisting of Wires Between Concrete Forms

A device, designed to eliminate all twisting of wires between forms in concrete work is manufactured by M. E. Saunier & Co., Bay City, Mich. The accompanying drawing shows the manner of operating this equipment, which is called the "Tite-Twister." It is claimed that it twists both wires uniformly so that a No. 8 wire will carry a load of 1,700 lb. There are no castings to nail to the forms, and one man is all that is required to apply or remove the wires. The manufacturer states that

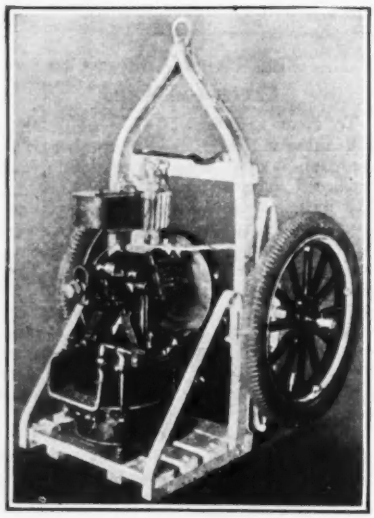


the tool is also suitable but rather light for column forms. A tool is, therefore, being developed that will handle No. 3 wire (¼ in. in diameter) on column forms.

Portable Trench Pump Driven by a Built-On Engine

A new gasoline-engine-driven portable trench pump unit designed especially for manhole work is a product of the Edson Mfg. Co., Boston, Mass. The trailer consists of a steam bowed wooden frame mounted on a pair of standard Ford front wheels. It may easily be moved from one manhole to another by one man. The pump is a 3-in. 4,000-g.p.m. diaphragm pump weighing 176 lb. New and improved features of the pump include a hinge that makes it possible to open the back head and replace it accurately in alignment without displacing the diaphragm

an a beveled rim and groove around the base to insure a proper centering of the diaphragm. The gasoline engine is mounted on top of the pump and



weighs 220 lb. It is air cooled and equipped with a high-tension magneto. The spark plug is of a waterproof type and all gears are inclosed, running in grease.

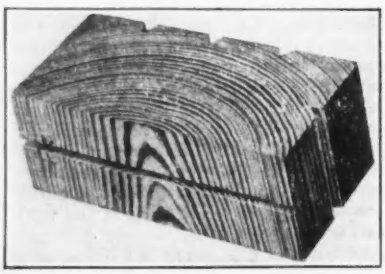
Emulsified Asphalt for Cold Application

An emulsified asphalt containing Standard Oil of California asphalt, 4 per cent colloidal clay and water is manufactured by the Crown Bitumens Corp., San Francisco, under the name of "Laykold." This product is shipped in barrels and contains no inflammable materials. It is a stable emulsion and is not affected by freezing.

The material is applied just as shipped and when the water evaporates, the result is said to be the same as if the asphalt had been applied hot. In addition to its use for building and repairing roads this emulsion has found application in grade crossings, tennis courts, floors, as a waterproofing substance for concrete structures, and as a non-corrosive paint for steel that is subject to acid fumes.

New Feature Facilitates Pouring Filler in Wood Block Floors

A $\frac{3}{16}$ x $\frac{3}{16}$-in. slot placed at right angles to the grain on the side of wood blocks opposite the side containing the grooves or lugs is claimed to materially aid in applying the pitch. A patent has been applied for on a block, known as



the Kreolite Join-Tite flooring, incorporating this feature, by the Jennison-Wright Co., Toledo, Ohio. Heretofore, it has been necessary to apply the filler two or three time in order to completely fill the joints since there was no quick way for the entrapped air to escape. With the Join-Tite flooring blocks, it is claimed that the air escapes along the slot until it passes through the groove vents. As the air escapes it permits the grooves and joints to be completely filled with the hot pitch at one application, thoroughly sealing all sides of the blocks to their full depth and eliminating the necessity of going back later to fill the joints flush with the surface of the block.

Publications from the Construction Industry

Built-up Roofing—BARRETT CO., New York, has made available a 34-p. catalog containing complete specifications and detail drawings of built-up roofing for flat roof decks. It contains 17 drawings of sufficiently large scale and of enough variety to be useful to contractors and builders who are confronted with diverse installations. This booklet is the first of a series which treats of the following subjects: Volume 1, Flat Roof Specifications; Volume 2, Steep Roof Specifications; Volume 3, Roof Flashing System; Volume 4, Roof Drainage System; Volume 5, Damp-Proofing and Water-Proofing.

Bucket Loaders—N. P. NELSON IRON WORKS, INC., Passaic, N. J., describes and illustrates its Type T Fordson bucket elevating loader, in a new booklet. The equipment is available with either wide-tired wheels or crawler treads.

Tunneling Shovel — MYERS-WHALEY CO., Knoxville, Tenn., has published a pamphlet descriptive of the design, manufacture, and use of its underground shoveling machine. The text consists of a reprint of a paper presented by William Whaley at a meeting of the Knoxville, Tenn., Section A.S.M.E.

Fans and Blowers — AMERICAN BLOWER CO., Detroit, Mich., is sending out Bulletin 1801, in which the company emphasizes the superiority of the "Sirocco" fan. Among other things claimed for it are great capacity for given dimensions, low speed for a given pressure, quietness, high mechanical efficiency and low operating cost. Of the 72 pages of the bulletin 43 are occupied with tables showing the capacity of the different types of fans manufactured by this company.

Structural Steel Buildings—TRUSCON STEEL CO., Youngstown, Ohio, has recently issued two new catalogs describing its line of steel building products. The first of these, called "Truscon Standards," describes the company's line of products, in which are included complete copper-steel buildings, either with pitched or flat roofs, steel windows with mechanical operators for controlling ventilation, reinforcing steel, steel joists, steel poles, foundry flasks, and building products, including such items as metal lath, window casements and lintels. The second booklet is entitled "Truscon Steel Joists." In addition to safe-load tables and explanations for figuring required sections, the booklet contains complete specifications for the joists, and information on installation and erection methods. A number of typical steel joist details are also shown and explained. The joists are suitable for all light occupancy buildings such as residences, office buildings and hotels.

Conveyor Chains — LINK-BELT CO., Chicago, has published booklet 755 describing its rivetless chains for conveyors and elevators. In addition to the descriptive matter and illustrations, there are included tables and line drawings giving ultimate strengths, weights and dimensions of the different sizes and styles of links.

Asphalt Paving Blocks — HASTINGS PAVEMENT CO., New York, has recently issued a pamphlet telling of the advantages of asphalt blocks for bridge and viaduct floors. Illustrations are given of some well-known structures that utilize this type of flooring.

Portable Carbide Lights—ALEXANDER MILBURN CO., Baltimore, Md., has issued a booklet describing the Milburn light which is suitable for use by contractors, railways, mines, and quarries engaged in night work. The lights are built in sizes up to 16,000 cp. and are operated by ordinary commercial carbide. Another booklet recently issued by this company describes its welding and cutting apparatus among which are included torches, regulators, gages, generators, and preheaters.

Trenching Machines—BARBER-GREENE CO., Aurora, Ill., shows both application views and machine details of its trench excavator, in a new catalog called "Cutting Mains and Services with a Barber-Greene Trencher." Illustrations show the machine digging post holes and operating in tight places.

Asphalt Filler — TEXAS CO., New York, in the new edition of its booklet, "Texaco Paving Filler," describes the methods of handling asphalt from the time it reaches the job until it is placed in the joints in the brick pavement. Illustrations are given of typical installations.

Ash-Handling Equipment — CONVEYORS CORPORATION OF AMERICA, Chicago, in its new booklet, "Ash and Soot Disposal," describes its steam jet conveyor installation in the new Milwaukee sewage plant.

Plastering — GENERAL FIREPROOFING CO., Youngstown, Ohio, in the June issue of its publication "The Right Angle," has published a number of articles dealing with better plastering practices.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Present Trend Is Toward Maintenance of High Wage Rates, Increasing Volume of Construction and Fewer Labor Troubles

The number of disputes placed annually before the U. S. Department of Labor have, with the exception of those for the year 1923, declined gradually since 1919.

Construction as measured by money value of contracts let, has gained steadily each year since 1921.

The trend is, therefore, in the direction of more work with fewer labor troubles.

Aside from the jurisdictional dispute between bricklayers and plasterers, affecting an enormous amount of construction in New York, Chicago, Washington and Detroit, there are few major labor disturbances at the present time in the construction industry.

In the bricklayer-plasterer controversy, a working agreement has been entered into between employers and members of the plasterers' union, whereby the latter may return to work.

The labor disputes referred to in Fig. 1 include other trades that those connected with construction. Recent troubles, affecting building trades mechanics, coal miners, transportation, clothing, mill and factory workers have failed, thus far, to disturb the steady expansion of the construction industry.

The wage trend in the highly organized, skilled trades has been consistently upward for the past twelve years. This is particularly true of building trades mechanics. With unskilled common labor the trend is in the opposite direction.

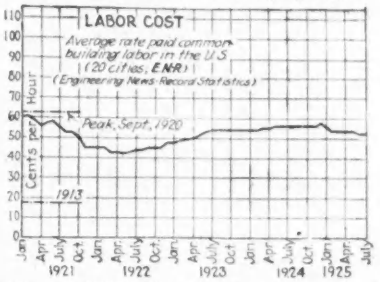


FIG. 3—COMMON LABOR WAGE RATE ON DOWN-TREND SINCE DECEMBER

One thing that may serve to check the rising tendency of bricklayers' wages is the increase in the number of apprentices. That this is being accomplished is suggested in the July report of the Common Brick Manufacturers' Association of America, as follows: "It is gratifying to note a tremendous increase in the number of journeymen bricklayers and apprentices. There has been much comment during the last few years to the effect that the number of journeymen brick masons has been decreasing and the small number of apprentices in this trade has been the basis of much publicity. The following are official figures of the Bricklayers, Masons & Plasterers International Union of America. It should be noted,

(*Continued on p. 204*)

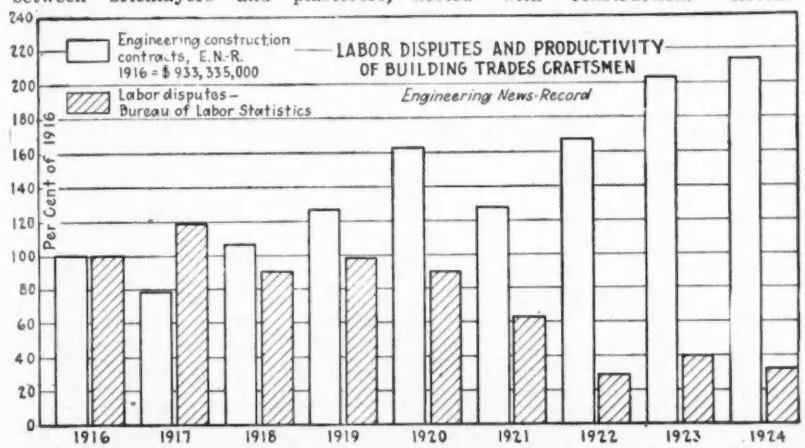


FIG. 1—MORE CONSTRUCTION ACCOMPLISHED WITH FEWER LABOR TROUBLES. DISPUTES BEFORE U. S. DEPT. OF LABOR IN 1916, 3,789

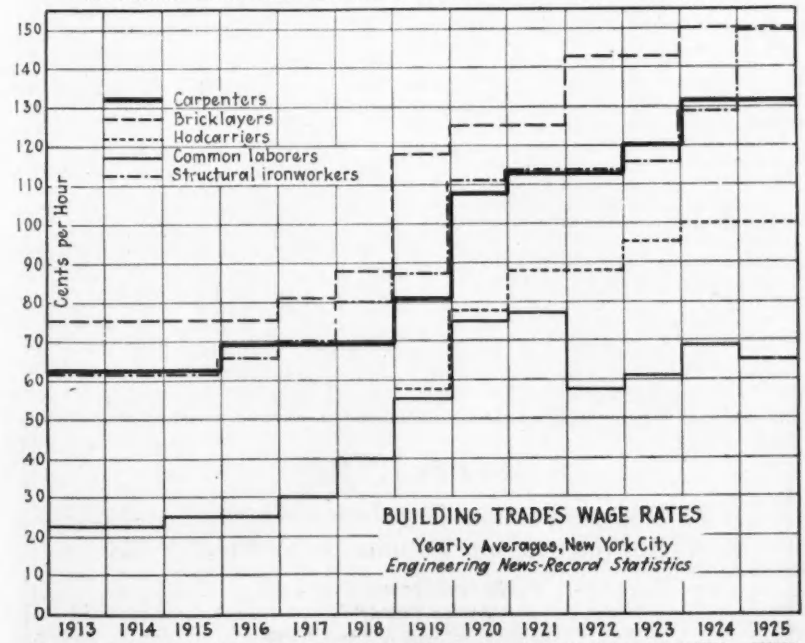


FIG. 2—WAGES OF SKILLED TRADES STEPPING GRADUALLY HIGHER. THIS IS TRUE OF NEARLY EVERY LOCALITY

This Week's Contracts—Week Ago—Same Week Last Year

The money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks.

Minimum costs observed are: $15,000 for water works and excavations, $25,000 for other public works, $40,000 for industrial and $150,000 for commercial buildings.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
July 30, 1925	**$19,352,000**	**$19,036,000**	**$38,388,000**
July 23, 1925	18,427,000	25,703,000	44,130,000
July 31, 1924	32,273,000	21,712,000	53,985,000
Heaviest Week			
1925, Apr. 2	43,603,000	27,633,000	71,236,000
1924, May 8	26,370,000	38,829,000	65,199,000
Jan. 1 to Date			
1925	604,007,000	752,584,000	1,356,591,000
1924	600,423,000	625,886,000	1,226,309,000

Weekly Construction Market

BUILDING materials are in good demand but prices show no marked tendency to advance, despite possibilities of fuel difficulties at manufacturing plants in the not distant future.

Prices of other commodities are tending upward, in the wholesale markets. There is improvement in demand in all directions, with less seasonal slowness than at this time last year.

Mill operations are heavier than a year ago in most of the building materials. Steel output has expanded slightly during the past week. Other industries such as textiles, leather, etc., are sharing in the increased activity. Non-ferrous metals are in better demand.

No actual scarcity of any basic materials exists. Buying is confined to small tonnage lots with quick mill deliveries. Record freight loadings, higher stock prices and firmness of money rates also testify to the soundness of underlying conditions.

Aside from slight fluctuations in pipe, concrete aggregates and lime and a drop of 1 to 6c. per gal. in raw linseed oil, during the week, prices of basic building materials are holding quietly to last week's levels.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.90	$4.00	$3.10	$3.35	$3.07½	$3.30	$3.35	$4.25
Structural rivets, 100 lb.	4.50	4.45	4.75	3.50	3.75	4.65	5.00	3.75	6.00
Reinforcing bars, ¾ in. up, 100 lb.	3.24	3.40	2.80	3.00	3.25	3.62½	3.35	3.25	2.30
Steel pipe, black, 3½ to 6 in. lap, discount	48%	—58%	53.6%	+51%	54.25%	36%	39.2@51%	50%	59.49
Cast-iron pipe, 6 in. and over, ton	50.60@51.60	—45.80	54.00	48.20@50.20	53.00	62.00	52.00	53.00	55.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.40	2.05	2.20	2.42	2.84	2.52	2.65	1.80
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	—1.90@2.20	1.65	1.90	2.15	1.50	1.25
Sand, cu.yd.	1.00	1.40	2.00	—1.90@2.20	1.25	1.00	1.50	1.50	1.25
Crushed stone, ¾ in., cu.yd.	1.85	2.00	2.83	—1.90@2.20	1.75	2.50	2.15	3.00	1.90
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	59.00	34.00	58.50	45.00@55.00	38.75	36.25	27.00	23.00	60.00
Lime, finishing, hydrated, ton	18.20	22.50	18.00	20.00	25.50	24.00	22.00	24.00	21.00
Lime, common, lump, per bbl	—2.25@2.75	1.45	1.85	—1.30	1.35	2.70	1.60	2.80	9.50
Common brick, delivered, 1,000	18@19	10.50	11.60	12.00	13.50	12.00	15.00	15.00	17.50
Hollow building tile, 4x12x12, per block	Not used	.0888	.10	.075	.....	.085	.....	.10	.12
Hollow partition tile 4x12x12, per block	.1162	.0888	.10	.075	.07	.085	.108	.10	.10
Linseed oil, raw, 5 bbl. lots, gal.	—1.01	—1.06	1.13	—96@100	—1.08	1.19	—1.10	1.12	1.25
Common Labor									
Common labor, union, hour	.75	.30		87½	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	30@.50	.75	.50@.55	.35@.50	.50	.50	.25@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime, in 280-lb. bbl. net, and hydrated lime f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Labor—Concrete laborers' rate, 93¾c.; building laborers, 75c.; excavating laborers, 55c. per hr.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone delivered on job.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. We quote on brown lime per 180-lb. net; white is $1.70 for Kelly Island and $1.60 for Sheboygan. Common labor not organized.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of July 2, the next on August 6.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net.

Dallas quotes lime per 180-lb. bbl. Steel, cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C. I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers.

Montreal quotes on pine lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; brick f.o.b. plant; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.12). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 3½-in., $59.49.

Present Trend Is Toward Maintenance of High Wage Rates, Etc.

(*Concluded from p. 203*)

however, that these figures cover stonemasons and plasterers in addition to bricklayers. The bricklayers, however, form by far the bulk of the craftsmen who are the members of this union. In July 1921 the total number of journeymen was 83,634. There were at that time only 1,437 apprentices being trained. In July 1922 the number of apprentices had risen to 3,623 with a total of 85,000 journeymen. In July 1923 the number of apprentices had increased about five times over the 1921 figures, standing at 7,263, with a total number of 97,300 journeymen. In 1924 the number of apprentices had increased to 10,656 with a total of 108,484 journeymen. In June 1925 there were 11,516 apprentices, or eight times the number existing in 1921, while the total number of journeymen had increased to 111,304."

On July 1, 1925

E. N.-R. Construction Cost Index Number 204.60

E. N.-R. Construction Volume Index Number 214

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month